

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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19950119033

TECHNICAL SUPPORT FOR ROCKY MOUNTAIN ARSENAL

Draft Final Work Plan
Offpost Operable Unit Remedial Investigation/
Endangerment Assessment/Feasibility Study

December 1989
Contract Number DAAA15-88-D-0021/0001
RIFS1

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PROGRAM MANAGER FOR
ROCKY MOUNTAIN ARSENAL

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RELEVANT PORTION OF THE ADMINISTRATION RECORD FOR THIS CERCLA
OPERABLE UNIT.

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1.0 INTRODUCTION

This Work Plan has been prepared by Harding Lawson Associates (HLA) for the Program Manager for Rocky Mountain Arsenal (PMRMA) for Delivery Order 0001 (RIFS1) of Contract DAAA-15-88-0021 between HLA and the U.S. Army Armament, Munitions and Chemical Command. This document presents the scope of work for additional data collection activities and interpretive efforts to be performed in the Offpost Operable Unit (OU) for preparation of (1) an addendum to the Offpost OU Final Remedial Investigation (RI) Report (ESE, 1988a) and (2) a revision of the Offpost OU Draft Final Endangerment Assessment/Feasibility Study (EA/FS) Report (HLA, 1989a).

An addendum to the Final RI Report will be prepared to present data generated after the Offpost OU RI was completed. This RI addendum will summarize data gathered and new or significantly modified interpretations of contaminant distribution. The information developed for the RI addendum will be utilized in revising the EA/FS Report. The EA/FS Report will be substantially revised on the basis of data presented in the RI addendum, with emphasis on possible new exposure pathways and development of remedial alternatives for media not considered in the previous EA/FS Report. In addition to data collected in this investigation, data from the Interim Response Action (IRA) currently being implemented by HLA north of the RMA boundary will be considered, as appropriate, in preparing the RI Report addendum and the revised Draft Final EA/FS Report.

1.1 DESCRIPTION OF STUDY AREAS

During development of the Draft Final EA/FS Report, the Offpost OU was divided into five areas on the basis of contaminant types, approximate concentrations, and general distribution. These three factors were further evaluated during review of the report and preparation of this Work Plan. These additional evaluations, which also were based on more recent data, have resulted in a slight adjustment of some of the study area boundaries, including extending the

southwest boundary of Study Area Ib to assess ground-water quality downgradient of the RMA northwest boundary. Current boundaries for study areas for the Offpost OU are shown in Figure 1.1-1.

1.2 SCOPE OF WORK

The general nature of the activities described in this document was discussed among the U.S. Department of the Army (Army), Shell Chemical Company (Shell), the U.S. Environmental Protection Agency (EPA), Colorado Department of Health (CDH), and U.S. Fish and Wildlife Service (USFWS). The specific activities to be performed for this effort were developed based largely on comments received from the Organizations (Army, Shell, and EPA) and State (CDH) (OAS). The review and comment process identified the need for additional data and evaluations pertaining to the extent of contamination in various media and the potential for these media to provide exposure pathways.

1.2.1 RI Addendum

In general, the RI addendum will summarize new information primarily pertaining to further assessment of the extent of contamination in various media (ground water, surface water, sediment, surface soil, and biota) within specific geographic areas. Activities necessary for preparation of the RI addendum include (1) a review of existing data and (2) collection and interpretation of additional field data to address identified data needs.

The sampling program described in this Work Plan has been designed to generate information necessary to address all identified data needs. The program was developed following review of appropriate documents, particularly reports that contain more recent data or data for media not sampled during the initial RI program. The following reports were reviewed:

1. Final Offpost OU RI Report (ESE, 1988a)
2. Comprehensive Monitoring Program (CMP) Annual Report for 1988 (RLSA, 1989)
3. RMA Water RI Report (Ebasco, 1989)
4. RMA Biota RI (ESE, 1989)

Explanation

- RMA Boundary: Dashed line
- Offpost Operable Unit Boundary: Solid line

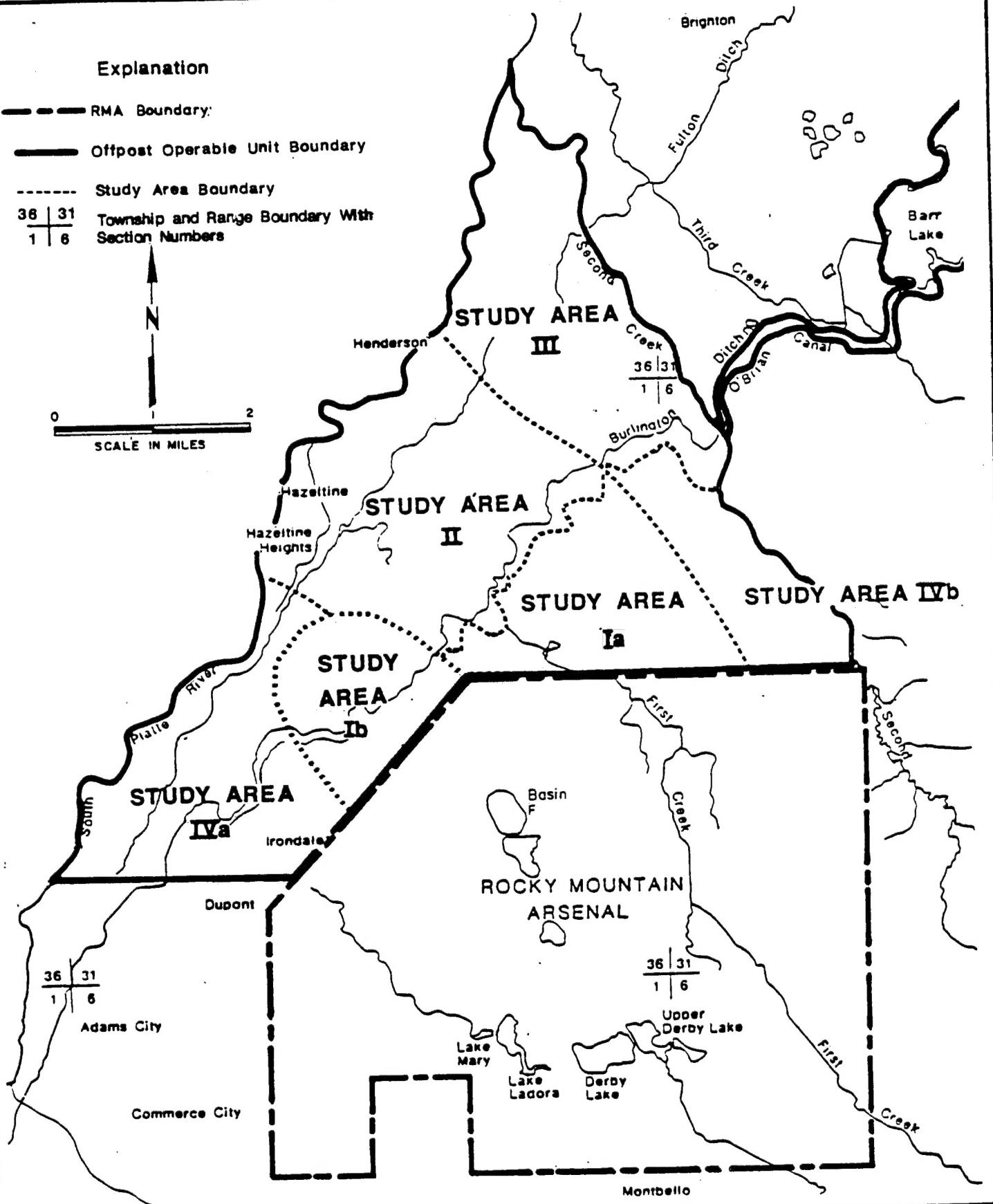
- Study Area Boundary: Dotted line

- Township and Range Boundary With Section Numbers: Dashed line

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1 | 6

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SCALE IN MILES



Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

Figure 1.1-1
STUDY AREAS FOR THE
OFFPOST OPERABLE UNIT
SOURCE: ESE, 1988a.

This review assisted in assessing the distribution of selected compounds in various media in the Offpost OU. Based on these reviews, appropriate areas were selected for additional sample collection. Procedures for collection and data evaluation will be consistent with those approved by the Army and specified in appropriate planning documents, as described in subsequent sections of this Work Plan.

A summary of the data needs for each medium within each study area is provided in Table 1.2-1. Further discussions of identified data needs and the programs proposed to address them are presented in Section 2.0.

1.2.2 EA/FS Report Revision

Rewvisions to the EA portion of the EA/FS Report will include modifications to or further explanation of several major components of the Draft Final EA/FS Report. Additional documentation will be provided to describe the process for selection of contaminants of concern and indicator chemicals. Based on results of additional data collection activities discussed in Section 2.0 of this Work Plan, new contaminants of concern or indicator chemicals in media not previously considered may be identified. These new data also will be considered in planned revisions to the fate and transport assessment presented in the initial EA/FS Report. The risk characterization section of the initial EA/FS Report will be revised to clarify several topics and to address issues including noncarcinogenic effects of carcinogenic compounds and development of a subchronic exposure scenario. Additionally, because the most likely maximally exposed individual for this assessment would be a hobby farmer residing in a portion of Study Area Ia near the intersection of 96th Avenue and Peoria Street, a focused risk assessment (RA) for current residents in this area will be performed. This assessment (96th Ave RA) will include interviews with residents to define existing land use and lifestyles and to develop possible exposure scenarios for the subject area. The results of the 96th Avenue RA will be summarized in the revised Draft Final EA/FS Report. A more detailed description of the anticipated

Table 1.2-1: Data Needs in Each Medium within Each Study Area

<u>Study Area</u>	<u>Media</u>	<u>Description of Need</u>
Ia	Alluvium/Ground water	Additional data on contaminant distribution and hydrogeologic character in the area immediately downgradient of the RMA northern boundary.*
	Surface water	Data on surface-water quality along First Creek and O'Brian Canal.
	Surficial soil	Data on contaminant distribution in surficial soils in the vicinity of First Creek, including assessment of background concentrations of selected compounds.
	Sediment	Data on distribution of contaminated sediments along First Creek and O'Brian Canal.
	Biota	Data on possible contamination of native and domestic biota in area immediately north of RMA northern boundary.
	VOC vapor accumulation	Data on possible accumulation of chloroform vapors in basements resulting from volatilization from the ground-water table.
Ib	Ground water	Additional data on contaminant distribution in the area downgradient of the RMA northwest boundary.
	Surficial Soils	Data on contaminant distribution in surficial soils, including assessment of background concentrations of selected compounds.
	VOC vapor accumulation	Data on possible accumulation of chloroform vapors in basements resulting from volatilization from the ground-water surface.
II	Ground water	Additional data on contaminant distribution in the area downgradient of the canals.
	Sediment	Data on distribution of contaminated sediments along Burlington Ditch.

* These data needs will be addressed during ongoing IRA investigation.

approaches to revising the EA Report, including performing the 96th Avenue RA, is provided in Section 3.0.

The FS portion of the EA/FS Report will be revised to reflect new information generated in the RI addendum process and conclusions developed in the revised EA portion. Because the initial version of the FS was conducted using methodology adopted from appropriate EPA guidance, it is anticipated that the basic methodologies employed will not require revision. A potentially major component to the revised FS portion will be evaluating the need for an alternatives analysis for media not considered in the Draft Final EA/FS Report. The revised FS will also consider additional media that were identified in the revised EA as posing a possible endangerment to human health or the environment but that were not considered in the initial EA/FS. A more detailed discussion of the revisions anticipated for the FS is provided in Section 4.0.

2.0 REQUIREMENTS FOR THE RI ADDENDUM

The RI addendum will include (1) site-specific data collected during the performance of the investigation outlined in this Work Plan, (2) site-specific data collected after completion of the Final RI Report but prior to this investigation and, (3) site-specific data collected concurrently under other site investigations. Pertinent data from published and private sources also will be utilized as appropriate.

The data required to supplement the RI can be classified into two general categories. The first category included additional data required to adequately assess contaminant plume boundaries and to address the interpreted contaminant plumes and isolated detections of contaminants in some wells. To address these data gaps, ground-water quality data will be collected from monitoring wells to be drilled in the unconfined aquifer within Study Areas Ib and II. The primary compounds of interest include organochlorine pesticides (OCPs), volatile organohalogens (VOHs), and diisopropylmethylphosphonate (DIMP):

The second category includes data necessary to supplement assessment of migration pathways. For a complete assessment of these pathways, contamination in various media, including surficial soils in Study Area Ia, sediment samples from O'Brian Canal or Burlington Ditch, selected species of biota in the area immediately north of RMA, and vapors accumulated in selected basements, will be investigated. The data collection programs proposed for each study area are described in this section.

2.1 BACKGROUND DATA

To assess the level of contamination in certain media, information on background levels of specific chemicals must be obtained. Information on background levels of pesticides in soils and shallow ground water, which is available from state and county agencies, will be reviewed and incorporated in the RI Addendum, as appropriate. Additional data in the form of private or published studies on various aspects of the geologic, hydrologic, climatic, or chemical conditions

of the Offpost OU and comparable areas also may be reviewed and assessed. The assessment of background data for surface soils also will incorporate data currently being gathered by the Army as part of an onpost program.

2.2 STUDY AREA Ia

Study Area Ia is located immediately downgradient of the RMA northern boundary, as shown in Figure 1.2-1. The study area is bounded by RMA on the south, O'Brian Canal on the northwest, and a diagonal line across Sections 12, 7, 18, and 17 on the northeast. First Creek enters the Study Area in south-central Section 13 and flows northwest to O'Brian Canal. The First Creek Impoundment is located along First Creek in southeastern Section 14. U.S. Highway 2 and the Burlington-Northern Railroad cross the study area near its western boundary.

Previous investigations have indicated the presence of two contaminant plumes, the Northern plume and the First Creek plume, within the study area. Both plumes consist of OCPs and volatile organic compounds (VOCs). These plumes generally coincide with two alluvial-filled bedrock paleochannels referred to as the First Creek Paleochannel and the Northern Paleochannel. The First Creek Paleochannel approximately parallels the present-day course of First Creek, and the Northern Paleochannel trends north from the RMA north boundary through the western portion of Section 13.

2.2.1 Data Collection Objectives

The data needs identified during review of the Final RI Report and the Draft Final EA/FS Report applicable to Study Area Ia pertain to the following:

1. Surface-water and stream and pond sediment quality, and the spatial variability of surface-water flows in First Creek between U.S. Highway 2 and 96th Avenue
2. The potential for contamination of biota with a home range limited to the study area
3. The potential for offpost surface-soil contamination and possible transport mechanisms

EXPLANATION

- Surface-Water Sampling Location (Nov. 1988)
- △ Sediment Sampling Location (Nov. 1988)
- ◆ Phase I Soil Sampling Location (Feb. 1989)
- Phase I Surficial Soil Sampling Location (Feb. 1989)
- Proposed Phase III Surface-Water Sampling Location
- Proposed Phase III Sediment Sampling Location
- ▲ Proposed Phase III Sediment Sampling Location

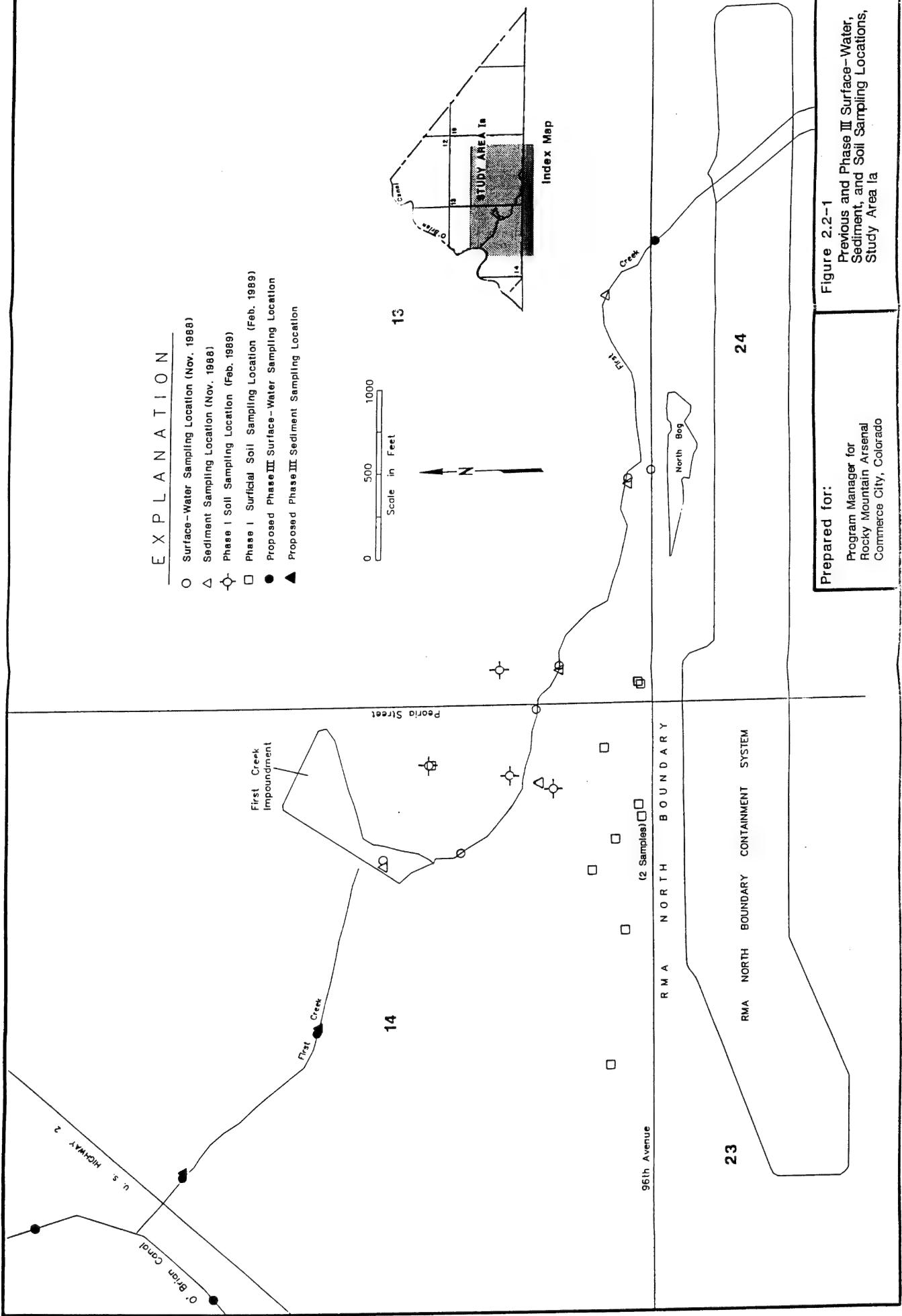


Figure 2.2-1 Previous and Phase III Surface-Water, Sediment, and Soil Sampling Locations, Study Area 1a

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Program Manager
Rocky Mountain
Commerce

The following scope of work has been developed to address the data needs described above.

1. Assess the nature and extent of surface and near-surface soil contamination between the RMA north boundary and O'Brian Canal
2. Evaluate contaminant transport mechanisms for surface soils to, within, and from areas near the First Creek flood plain
3. Assess First Creek and O'Brian Canal as a potential contaminant pathway to Barr Lake
4. Assess the biological and ecological conditions that exist along the course of First Creek
5. Assess potential contamination of biota (both native and agricultural) within the study area, particularly within the First Creek flood plain
6. Assess the relationship between the First Creek surface-water regime and the shallow ground-water regime

2.2.2 Technical Approach and Data Collection Program

Preliminary sampling of surface water, stream and pond sediments, soil, and biota in the First Creek area was performed in November 1988. A phased program referred to as the "First Creek Offpost Investigation" was developed, and Phase I sampling under that program was conducted in February 1989. Figure 2.2-1 shows sampling locations for samples collected under the preliminary program and subsequent phases. Phase II sampling was conducted between April and August 1989. Biota sampling locations for Phase II are shown on Figure 2.2-2. Additional phases of the First Creek program and additional activities necessary to satisfy overall program objectives are described below.

Preliminary Sampling - November 1988

1. Collection and analysis of surface-water samples from First Creek and the First Creek Impoundment
2. Collection and analysis of stream and pond sediment samples from First Creek and the First Creek Impoundment
3. Collection and analysis of shallow soil samples in and near the channel of First Creek
4. Collection and analysis of whole fish samples from the First Creek Impoundment

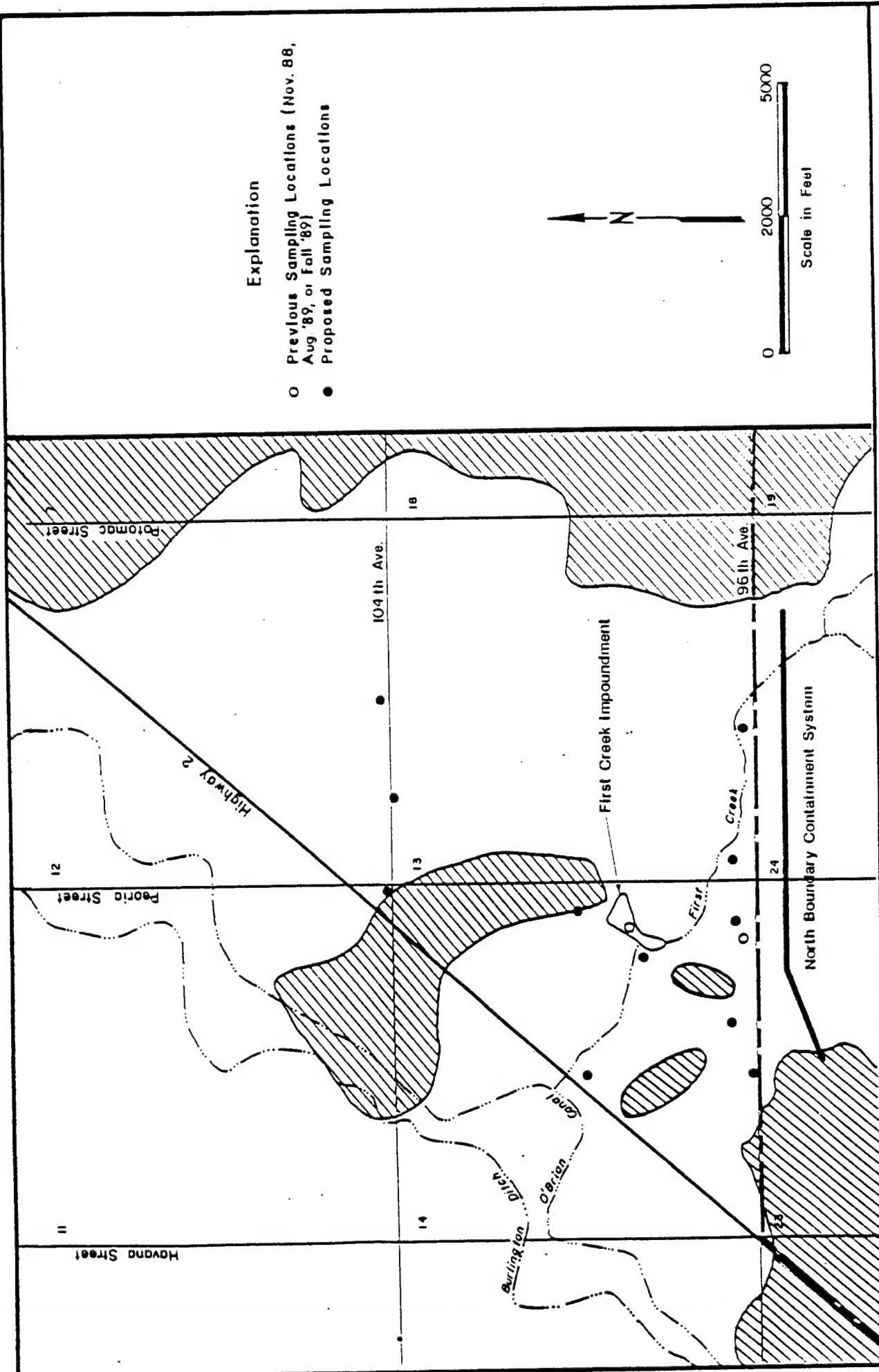


Figure 2.2-2 PREVIOUS AND PROPOSED BIOTA SAMPLING LOCATIONS

Prepared for:
Program Manager for
Rocky Mountain Arsenal
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Phase I - February 1989

1. Collection and analysis of shallow soil samples within and outside the First Creek flood plain
2. Collection and analysis of surficial soil samples outside the First Creek flood plain

Phase II - April through August 1989

1. Collection and analysis of ground-water tap samples from area residences
2. Collection and analysis of agricultural chicken egg samples from a farm along 96th Avenue
3. Collection and analysis of milk and body fat samples from beef cattle raised on a farm along 96th Avenue

Phase III - Planned

1. Estimation of surface-water flow at several locations along First Creek
2. Collection and analysis of surface-water and stream and pond sediment samples from First Creek, the First Creek Impoundment, and O'Brian Canal and Burlington Ditch
3. Collection and analysis of agricultural and native biota samples from the study area
4. Assessment of biological and ecological conditions along the course of First Creek
5. Collection and analysis of additional surficial soil samples, as needed

The following sections provide additional detailed descriptions of the planned sampling activities in each medium. The analytical suite for each medium is discussed in Section 2.5.7.

2.2.2.1 Surface Water

In November 1988, six surface-water samples were collected along First Creek and from the First Creek Impoundment as part of the preliminary First Creek assessment. As a part of Phase III of the assessment, surface-water sampling will be conducted at five additional locations, which are shown in Figure 2.2-1. These sampling locations are as follows:

- One location along First Creek immediately upstream of 96th Avenue
- Two locations along First Creek downstream of the First Creek Impoundment

- Two locations along O'Brian Canal, one upstream of the First Creek confluence and one downstream; the exact sampling locations along O'Brian Canal will be decided following a reconnaissance of the canal

The analytical suite for surface-water quality assessments (Section 2.5.7) will be the same as the suite currently used in the CMP, with the following additions for all samples:

1. Sulfide
2. Ammonia nitrogen
3. Biological oxygen demand (BOD)

The quantity of surface-water flows along First Creek also will be assessed at approximately 10 locations at intervals of approximately 500 feet through either visual observations or stream gaging.

2.2.2.2 Sediment

As part of the preliminary First Creek Assessment, five sediment samples were collected in November 1988 from locations in and along First Creek and the First Creek Impoundment. These sampling locations are shown in Figure 2.2-1. Two of the samples were collected underwater from the First Creek Impoundment and from the First Creek Channel on the north side of 96th Avenue. The other three samples were collected from normally dry areas that are inundated during higher water events.

Stream sediment quality will be further assessed through sampling at 7 locations along First Creek and O'Brian Canal during Phase III. Two of the sediment samples will be collected from First Creek along the reach from the First Creek Impoundment to the confluence with the O'Brian Canal. To the extent possible, these sampling points will be collocated with the surface-water sampling locations previously described. The remaining five samples will be collected from the O'Brian Canal along the reach extending from upgradient of the confluence with First Creek downgradient to Barr Lake, with some of these samples collected from Study Area IVb, One or

two of the five samples will be collected from upstream of the O'Brian Canal/First Creek confluence.

The specific sampling locations along the canal will be selected after access to the land has been arranged with the landowners, as described in Section 2.5.1. It is intended that the locations will be evenly spaced along the reach from First Creek to Barr Lake, although some adjustment is anticipated to allow for field access and physical conditions in the canal.

2.2.2.3 Shallow Soils

As part of the Phase I First Creek investigation, six soil samples were collected at four locations within and near the First Creek flood plain, as shown in Figure 2.2-1. Samples were collected from the 0- to 1-foot interval at two of the locations near the current First Creek drainage course. Phase I samples from the 0- to 1-foot and 4- to 5-ft. intervals also were collected at one location outside the current drainage course; but within the suspected flood plain north of First Creek in Section 13, and at a second location outside the suspected flood plain north of First Creek in Section 14. The water table was encountered at a depth of 4.5 feet in the boring located in Section 13 within the suspected First Creek flood plain.

No additional shallow soil samples will be collected during the Phase III investigation.

2.2.2.4 Surficial Soils

Under Phase I of the First Creek assessment, 11 surficial soil samples were collected outside the suspected First Creek flood plain in Sections 13 and 14 (Figure 2.2-1). At each location, samples were collected from the top 2 inches of soil from several areas within a 2-foot sampling radius and composited for analysis.

Additional surficial soil sampling is anticipated. As discussed with the OAS, the specific sampling locations for surficial soils offpost will be based in part on the results of the current onpost surficial soil sampling program. Those data are considered an important component in assessing the contaminant distribution in the offpost surficial soils. An understanding of these

data will permit an assessment of possible transport pathways for contaminated surficial soils when designing the offpost program. Although specific sampling locations are not known at this time, the Army expects to collect, within the next few months, approximately 10 additional surficial soil samples offpost. The general sampling locations are likely to be north of RMA in the northern half of Sections 13 and 14 and southern half of Sections 11 and 12. Additionally, available background data for surface soils will be gathered and assessed, as discussed in Section 2.1. If data are not available for compounds considered critical in the interpretation of the surficial soil results, additional background samples may be collected. The OAS will be informed of locations prior to sampling either through a letter or a brief working meeting.

2.2.2.5 Biota Sampling

Biota samples were collected in the preliminary and Phase II components of the First Creek assessment, as shown on Figure 2.2-2. In the preliminary phase conducted in November 1988, three fish samples were collected from the First Creek Impoundment. Subsequent biota sampling conducted in Phase II, included collection of eggs from agricultural chickens and milk and body fat from cows from a small farm located near the intersection of Peoria Street and 96th Avenue. In general, these samples were collected at the request of residents who expressed concerns about possible contamination in agricultural animals.

Additional biota sampling is planned, as shown on Figure 2.2-2. The proposed sampling program includes collection of a number of aquatic and terrestrial organisms within about a mile of the RMA north boundary. The details of the program are provided below. Some species may be difficult to obtain due to site-specific conditions (e.g., soil moisture) and it may not be possible to collect all planned samples at all proposed locations. Where necessary, small deviations to the planned biota sampling program may be made to attempt to achieve the program objectives.

The biota sampling program consists of the following:

1. An aquatic survey of the First Creek Impoundment will be performed, including collection of two composite samples of aquatic invertebrates, two composite samples of

aquatic plants, and two composite samples of small fish. Additionally, the First Creek Impoundment will be characterized considering (1) species and distribution of aquatic and emergent vegetation, (2) types of vertebrates and invertebrates present, and (3) an assessment of water depth, temperature, and degree of disturbance (e.g., use by cattle).

2. Terrestrial organisms also will be collected, including up to 10 pheasants, 3 composite samples of earthworms, 6 composite samples of grasshoppers, 3 composite samples of field mice (*Peromyscus*), and 3 samples of prairie dogs.

2.2.2.6 Ecologic Characterization of Study Area

An ecological characterization of Study Area Ia will also be performed. The characterization will consist of office and limited field studies. A habitat map will be constructed of Study Area Ia. The map will be drawn as a rough draft on aerial photography and will delineate areas of aquatic and terrestrial habitat including wetlands, riparian woodland, grassland, fencerows, weedy areas, and other habitats of biological significance. Human land uses (e.g., residential) and areas of disturbance will also be indicated.

An inventory of aquatic and terrestrial vertebrates species and important invertebrate groups also will be prepared. The list will include common and scientific names, general habitat preference, and season of occurrence, as appropriate. Field visits will be made to the area to groundtruth the habitat map, record any changes in land use or condition, and note dominant vegetation in each habitat. Wildlife observations also will be performed during these visits, and the location and habitat recorded.

2.2.2.7 Air Sampling in Basements

The Draft Final EA/FS reported that accumulation of volatile organic chemical vapors in household basements could represent a potential exposure pathway to residents in the Offpost OU. To assess the potential impact of vapor accumulation, air samples will be collected from a number of basements in Study Area Ia (see Section 2.3.2). The exact locations for sampling have not yet been determined, and require further assessment of chemical data and water level information in the area followed by a number of site visits and discussions with residents to ascertain the appropriateness of collecting air samples from their basements. The samples will

likely be collected from basements situated above volatile organic plumes where ground water is at shallow depths. The Army will assess pertinent available data and notify the OAS of recommended sampling locations prior to actual sample collection. Notification of the OAS will consist of a letter from the Army or a brief working meeting. Sample collection procedures are described in Section 2.5.3.7.

2.3 STUDY AREA Ib

Study Area Ib is located immediately downgradient of the northwest boundary of RMA (Figure 1.1-1) and encompasses the known and suspected extent of contamination in this area. As previously noted, the southwest boundary of Study Area Ib has been extended from that delineated in the Draft Final EA/FS to include the probable maximum extent of ground-water contamination downgradient of the RMA northwest boundary.

2.3.1 Data Collection Objectives

The data needs identified during review of the Final RI Report and the Draft Final EA/FS Report applicable to Study Area Ib pertain to the following:

1. Additional monitoring wells in the unconfined aquifer to the west and northwest of the Northwest Boundary Containment System (NWBCS) for refining the extent of shallow ground-water contamination in the area.
2. Assessment of the lateral extent of dieldrin and chloroform near the northern or southern ends of the NWBCS.
3. The potential for accumulation of chloroform vapors in basements resulting from volatilization from the ground-water surface.
4. The potential for offpost surface-soil contamination and possible transport mechanisms.

The following scope of work has been developed to address the data needs described above:

1. Additional monitoring wells will be installed in the unconfined aquifer. Water-quality information from these wells will be used to further assess the nature and extent of contamination in the unconfined flow system. Specifically, the data will be used to assess the lateral extent of chloroform and dieldrin contamination.
2. Air samples will be collected from basements to assess whether volatiles, such as chloroform, are migrating from the water table through the soil and basement floors and accumulating in the basements.

3. Assess the nature and extent of surface and near-surface soil contamination occurring in Study Area Ib between the RMA northwest boundary and Highway 76.
4. Evaluate possible transport mechanisms for surface soils to areas in the study area.

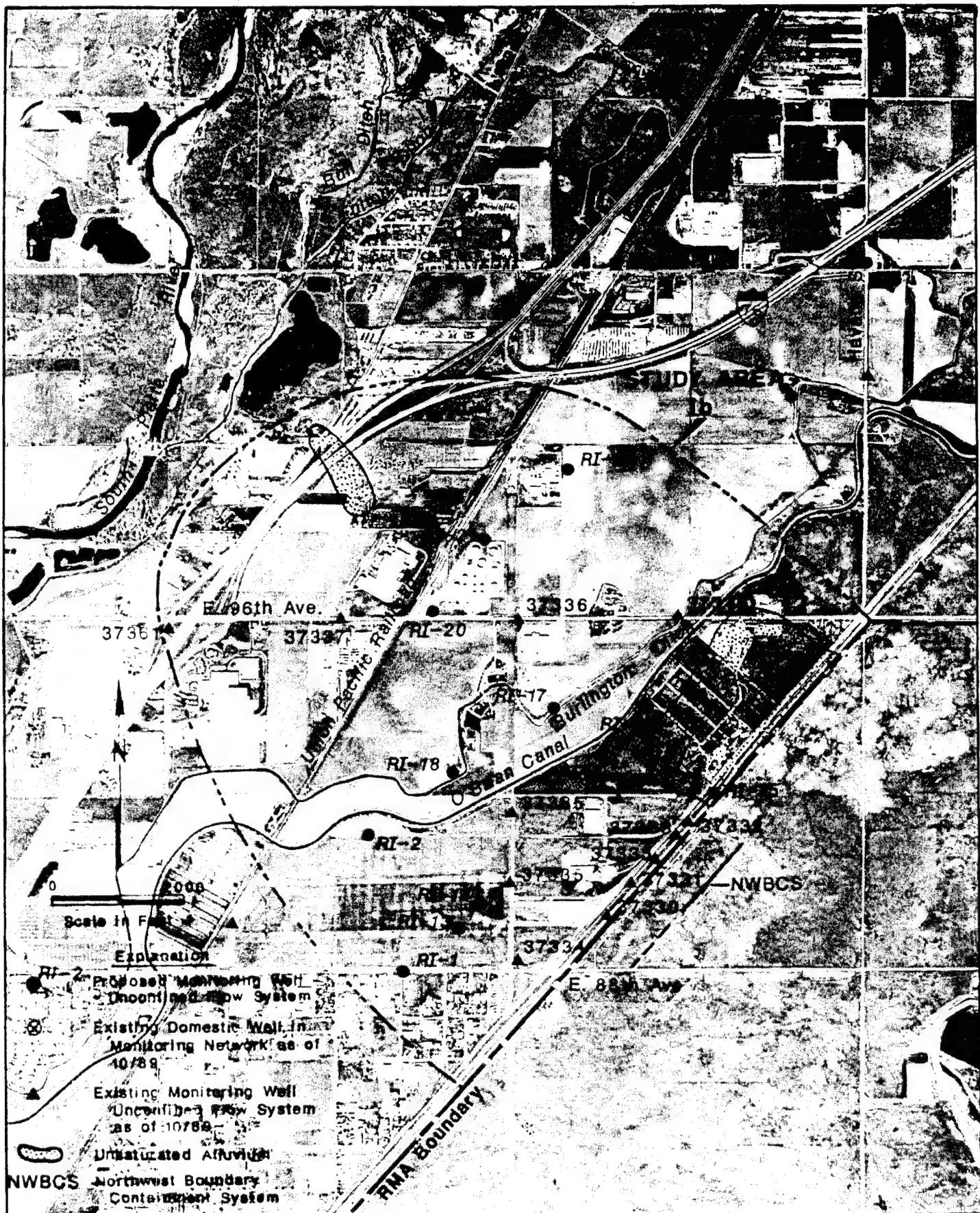
2.3.2 Technical Approach and Data Collection Program

The program developed to meet the objectives for Study Area Ib includes the installation and sampling of 12 additional monitoring wells completed within the unconfined aquifer. Air sampling in selected basements and collection of surface soil samples also will be conducted. Details of the program, including the technical justification for each new monitoring well, are provided below.

2.3.2.1 Ground Water

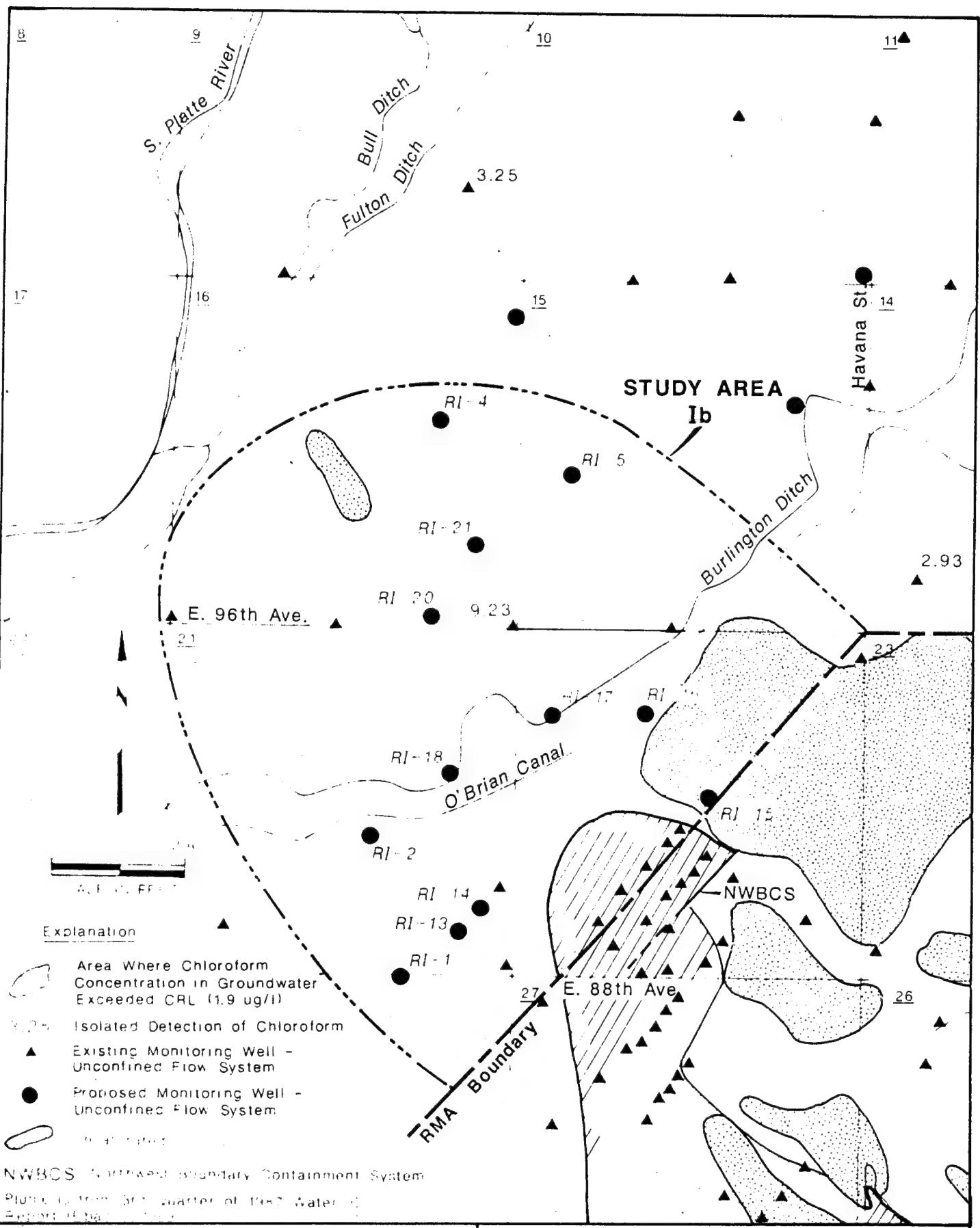
The locations of existing and proposed monitoring wells within Study Area Ib are shown in Figure 2.3-1. Chloroform and dieldrin are the primary contaminants of concern detected in samples from monitoring wells in Study Area Ib. The lateral extent of chloroform and dieldrin is shown in Figures 2.3-2 and 2.3-3, respectively. As shown in the figures, additional monitoring wells along the suspected perimeter of the contaminant plumes are necessary to further assess the lateral extent of chloroform and dieldrin contamination. The lateral extent of contaminants potentially migrating past the northern and southern ends of the NWBCS cannot be evaluated without additional monitoring wells. The additional monitoring wells proposed for the unconfined flow system have been located to (1) further refine the extent of chloroform and dieldrin contamination and (2) assess possible impacts of paleochannels on contaminant distribution. These locations were presented to the OAS in a technical working session held on November 1, 1989. The technical justification for each of the proposed wells is provided below.

1. Well RI-1 will be used to further refine the western extent of dieldrin contamination between wells 37334 and 37360. The well will be located along a bedrock paleochannel that is suspected of influencing contaminant migration. The well is intended to assist in defining the potential migration of dieldrin past the southwest end of the NWBCS.



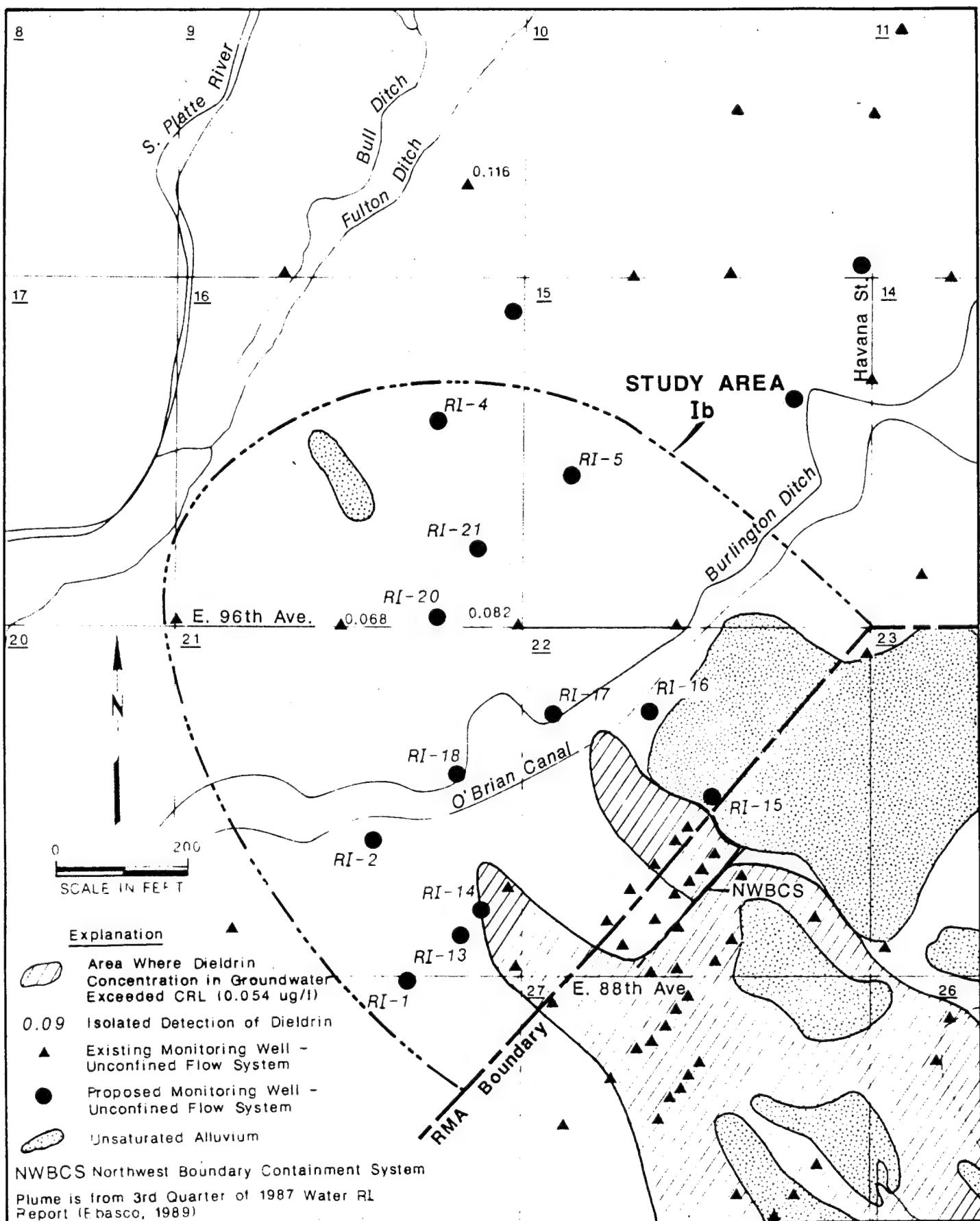
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Figure 2.3-1
PROPOSED AND EXISTING MONITORING
WELLS, STUDY AREA Ib



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Commerce City, Colorado

Figure 2.3-2
CHLOROFORM IN THE
UNCONFINED AQUIFER, STUDY
AREA Ib



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 Commerce City, Colorado

Figure 2.3-3
 DIELDRIN IN THE UNCONFINED
 AQUIFER, STUDY AREA Ib

2. Well RI-2 will be used to further refine the western extent of dieldrin contamination detected in wells 37334, 37335, and 37385. Specifically, it is downgradient of Well 37334 and proposed wells RI-13 and RI-14 and will provide better plume definition in the area.
3. Well RI-4 will be used to further refine the downgradient extent of dieldrin and chloroform contamination in the vicinity of wells 37337 and 37336 and proposed well RI-21. It will also be used to assess whether continuous plumes of chloroform and dieldrin exist between these wells and well 37355 in Study Area II.
4. Well RI-5 will be used to further refine the northeastern extent of chloroform and dieldrin contamination detected in well 37336. The continuity and significance of the apparently isolated detections in nearby wells (37345, 37351, and 37398) also can be assessed with information from the proposed well.
5. Well RI-13 will be used to refine the downgradient extent of dieldrin frequently detected in existing well 37334 and will be used to delineate the southwestern extent of dieldrin at the south end of the NWBCS. Geologic data from this well also will provide better definition of a suspected paleochannel in this area.
6. Well RI-14 will be used for the same purposes as proposed well RI-13. The well will be located about 500 to 600 feet northeast of RI-13.
7. Well RI-15 will be used to evaluate the northeastern extent of dieldrin or chloroform possibly bypassing the NWBCS to the north. The proposed location is along an interpreted paleochannel, which could influence contaminant migration. An unsaturated area is present to the northeast; therefore, a well will be installed only if sufficient alluvial ground water is present.
8. Well RI-16 will be used to evaluate the northern lateral extent of dieldrin and chloroform detected in well 37382. The extent of an unsaturated area to the east/southeast will be evaluated, and a well will be installed only if sufficient ground water is present.
9. Well RI-17 will be used to evaluate the downgradient extent of dieldrin and chloroform detected in well 37382. It also will be used to evaluate the continuity of the plumes suspected to extend from well 37382 to well 37336. Dilution effects from O'Brian Canal and Burlington Ditch also may be clarified.
10. Well RI-18 will be used to evaluate the downgradient extent of dieldrin and chloroform detected in well 37385 and to assess whether the detections at downgradient well 37337 could originate from a plume at well 37385. The proposed location is along an interpreted paleochannel, which could influence flow direction. Dilution effects also can be evaluated because the well will be downgradient of O'Brian Canal and Burlington Ditch.
11. Well RI-20 will be used to assess the lateral extent of contamination and plume dimensions between wells 37336 and 37337. It will be used to assess whether continuous plumes are present in this area.
12. Well RI-21 will be used to assess the downgradient extent of contaminants detected at well 37336 in an area suspected to be near the terminus of the dieldrin and chloroform plumes.

The proposed wells also will provide data to verify the extent and continuity of other contaminant plumes in the area.

All wells installed in Study Area Ib will be sampled twice under this task and then evaluated for possible inclusion in the CMP. Wells will be sampled initially approximately two weeks after development and again after 8 to 10 weeks to verify initial results. Also, attempts will be made to sample a number of existing wells during the second sampling event to assess contaminant plume boundaries. The results will be evaluated and used in preparation of the RI Addendum.

2.3.2.2 Surficial Soils

Surficial soil samples will be collected at approximately five locations in Study Area Ib. This purpose and rationale for this sampling program is similar to that of the surface soil sampling program being conducted for Study Area Ib, as previously described in Section 2.2.2.4. The general sampling locations are likely to be evenly distributed in Study Area Ib between the RMA northwest boundary and State Highway 76. Actual locations will be selected based on results of the onpost surficial soil sampling program. Additionally, available background data for surface soils will be assessed, as discussed in Sections 2.1 and 2.2.2.4. The OAS will be informed of sampling locations prior to sampling either through a letter or a brief working meeting.

2.3.2.3 Air Sampling in Basements

As described in Section 2.2.2.6, the Army will collect air samples from selected basements to assess that potential exposure pathway for Study Area Ia. The Army also will collect air samples from a number of basements situated in Study Area Ib. The assessment of data to adequately define sampling locations also will be performed for Study Area Ib. Sample collection procedures are described in Section 2.5.3.7.

2.4 STUDY AREA II

Study Area II is located immediately downgradient of Study Area Ia and is bounded on the southeast by O'Brian Canal and on the northwest by the South Platte River (Figure 1.1-1). DIMP, dieldrin, chlorobenzene, chloroform, and tetrachloroethane have been identified in samples from wells in this study area.

2.4.1 Data Collection Objectives

The data needs identified during review of the Final RI Report and the Draft Final EA/FS Report applicable to Study Area II pertain to the following:

1. Additional well control upgradient of apparently isolated detections of some chemical compounds is necessary to permit delineation of possible migration pathways, particularly for DIMP in a agricultural well located in Section 9.
2. Additional well control immediately downgradient of O'Brian Canal and Burlington Ditch to assess dilution of contaminant plumes by recharge from the canals.
3. Stream sediment quality along Burlington Ditch.

The following scope of work has been developed to address the data needs described above:

1. Potential contaminant migration pathways will be assessed, and monitoring wells will be installed in areas to better define the lateral edges of plumes and apparent isolated detections in wells in Study Area II.
2. New monitoring wells will be installed to assess the dilution of contaminants of concern across Burlington Ditch and O'Brian Canal.
3. The lateral and distal extent of suspected plumes will be refined on the basis of analytical results from new and existing wells.
4. Assess Burlington Ditch as a potential migration pathway for RMA-derived contaminants.

2.4.2 Technical Approach and Data Collection Program

The locations of the existing and proposed monitoring wells in Study Area II are shown in Figure 2.4-1. The area immediately downgradient of O'Brian Canal and Burlington Ditch was evaluated with respect to (1) the leading edges of plumes originating in Study Area Ia and (2) isolated detections in wells further downgradient in Study Area II. Figure 2.4-2 shows the

Explanation

- Proposed Monitoring Well
Unconfined Flow System
- ▲ Existing Monitoring Well as of '93
Unconfined Flow System
- Existing Domestic Well in Monitoring
Network as of '93
- ◆ Unsaturated Alluvium
- NBOCS North Boundary Containment System

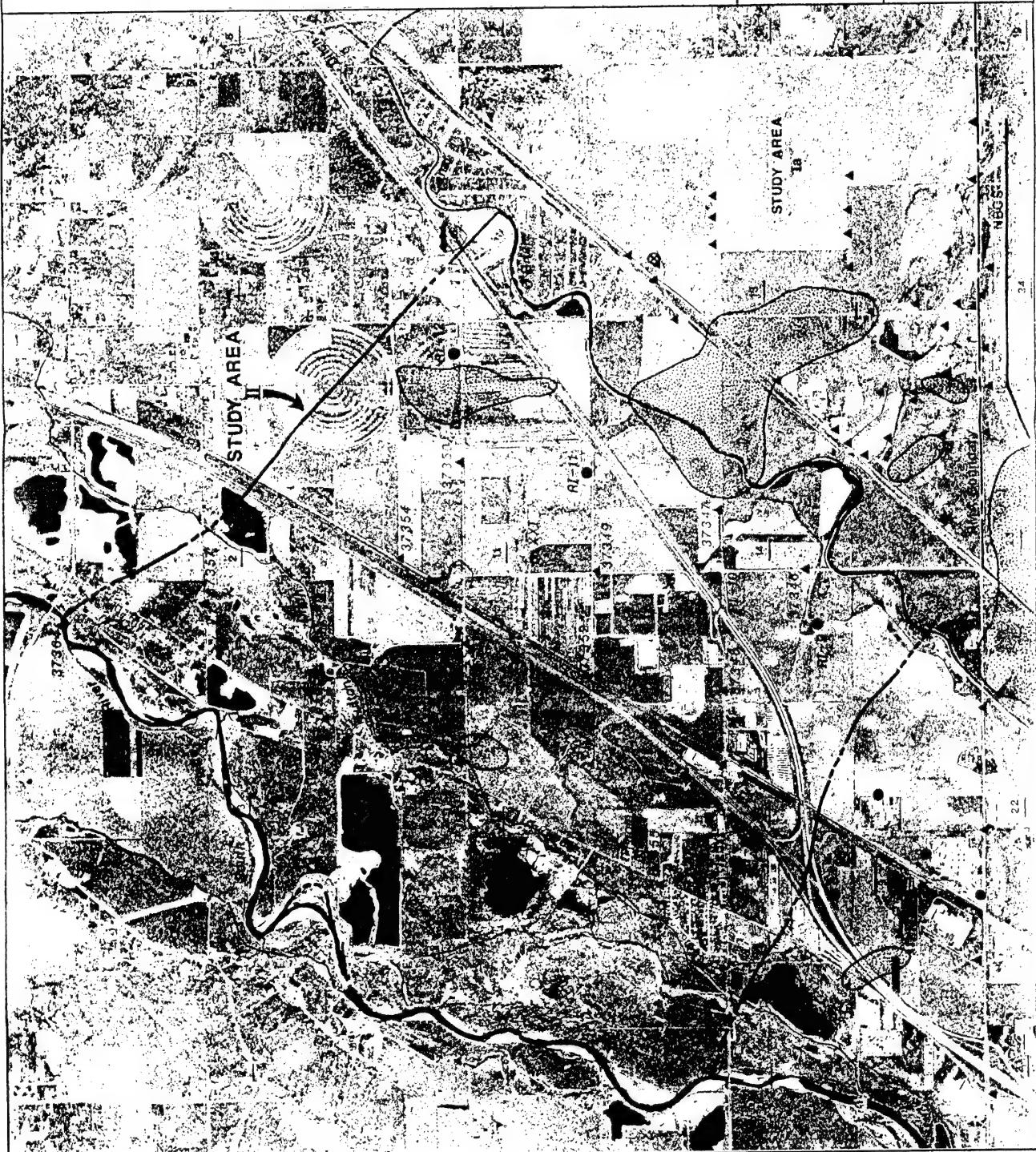


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FIGURE 2.4-1
PROPOSED AND EXISTING MONITORING
WELLS.
STUDY AREA II



Explanation

Area where Chlorobenzene, Chloroform, and/or Tetrachloroethylene Concentrations in Ground Water Exceeded CRL

Chlorobenzene (CLC6HS)	1.4 ug/l
Chloroform (CHCL3)	1.9 ug/l
Tetrachloroethylene (TCLEE)	2.8 ug/l

7.39 Isolated Detection of Contaminant

Existing Monitoring Well-3rd Qtr.87
Unconfined Flow System

Unconfined Domestic Well
Sampled - 3rd Qtr. 87

Proposed Monitoring Well-
Unconfined Flow System

Unsaturated Alluvium as defined 1988
NBCS North Boundary Containment System

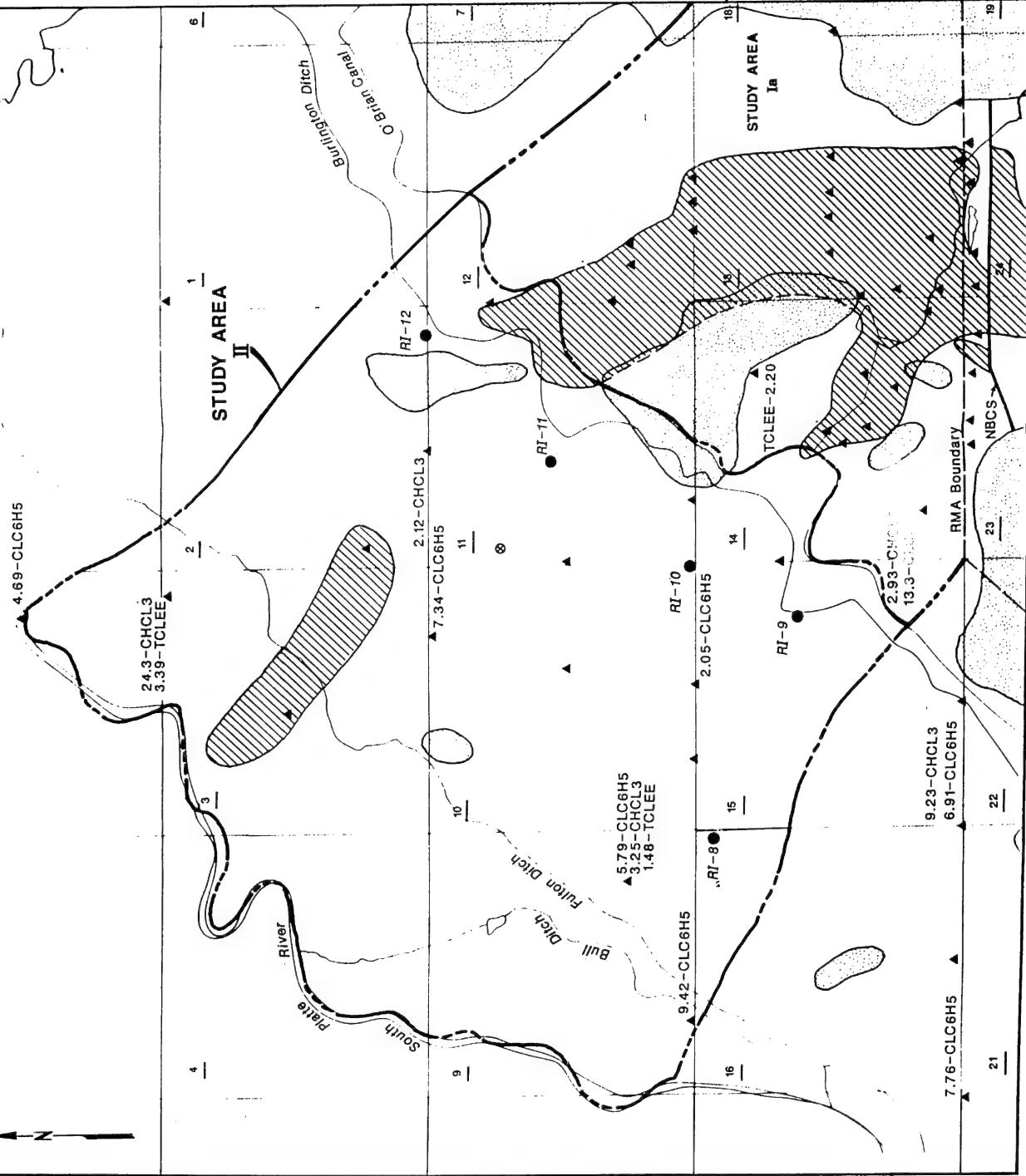
0 2000 4000
Scale in Feet

Plume is a Composite from 3rd Qtr. 87 Water RI Report (EPA/DOE, 1989)

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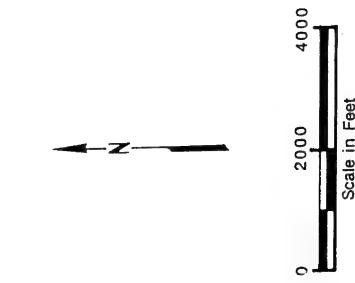
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FIGURE 2.4-2
VOLATILE ORGANIC COMPOUNDS
IN THE UNCONFINED AQUIFER,
STUDY AREA II



Explanation

- Area where DIMP Concentration in Groundwater Exceeded CRL (10.5 ug/l)
- 12.4 Isolated Detection of DIMP
- Existing Monitoring Well - 3rd Qtr.'87 Unconfined Flow System
- Unconfined Domestic Well Sampled - 3rd Qtr.'87
- Proposed Monitoring Well - Unconfined Flow System
- Unsaturated Alluvium as defined in 1988
- North Boundary Containment System (NBCS)



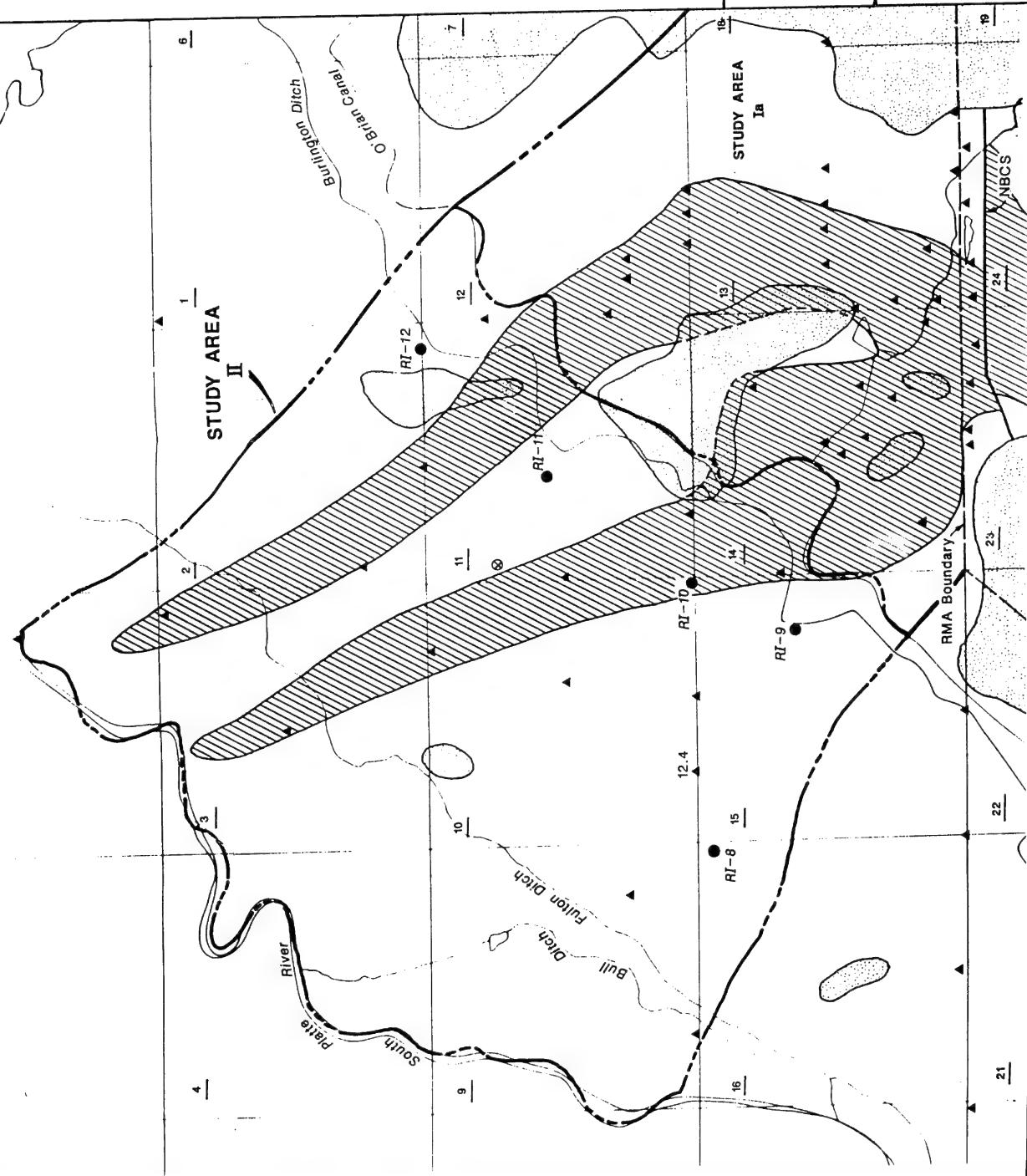
Plume is from 3rd Qtr. '87 Water RI Report (EBASCO, 1989)

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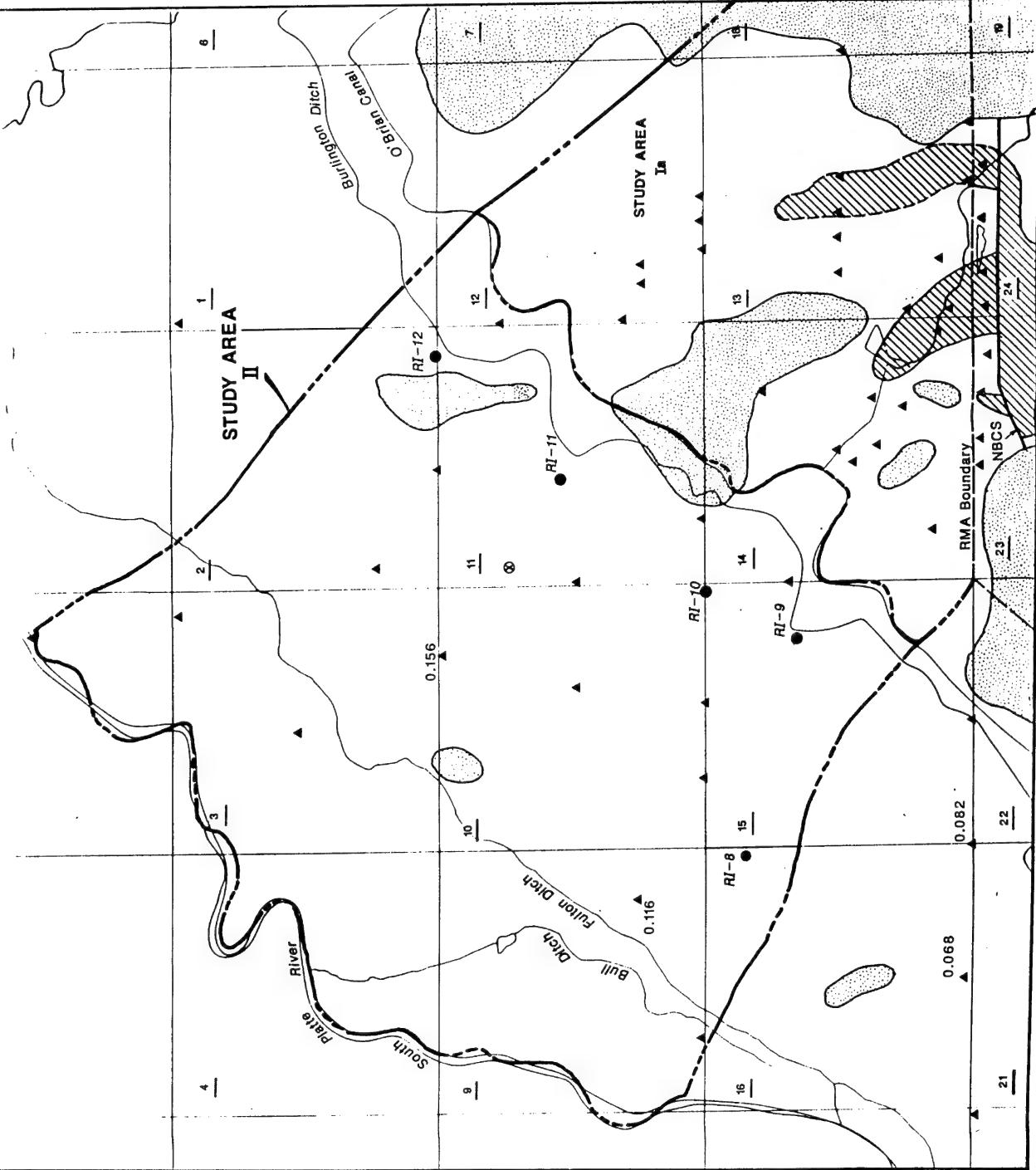
FIGURE 2.4-3

DIMP IN THE UNCONFINED AQUIFER,
STUDY AREA II



Explanation

- Area where Dieldrin Concentration in Groundwater Exceeded CRL (0.06 ug/l)
- 0.116 Isolated Detection of Dieldrin
- Existing Monitoring Well – 3rd Qtr '87 Unconfined Flow System
- Unconfined Domestic Well Sampled – 3rd Qtr '87
- Proposed Monitoring Well – Unconfined Flow System
- Unsaturated Alluvium as defined in 1988
- NBCS North Boundary Containment System



Plume is from 3rd Qtr '87 Water RI Report

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FIGURE 2.4-4

DIELDRIN IN THE UNCONFINED
AQUIFER, STUDY AREA II

maximum extent of the contaminant plumes and isolated detections for selected volatile organic compounds, including chlorobenzene, chloroform, and tetrachloroethylene in wells sampled during the third quarter FY87 (Ebascc, 1989). Figures 2.4-3 and 2.4-4 show the extent of DIMP and dieldrin, respectively.

The rationale for the location of each proposed monitoring well is as follows.

1. Well RI-8 will be used to address isolated detections of dieldrin, chlorobenzene, chloroform, tetrachloroethylene, and DIMP. Additionally, because there is limited well control in the immediate area of the proposed location, the location will be useful in assessing the distal extent of the plumes emanating from Study Area Ib.
2. Well RI-9 will provide downgradient control for contaminants migrating across the canals and information regarding contaminant dilution. Additionally, because there is limited well control in the immediate area of the proposed location and the well is located upgradient of isolated detections of DIMP and chlorobenzene, this location will be useful in assessing possible contaminant migration pathways.
3. Well RI-10 will provide upgradient control for detections of DIMP and dieldrin in wells 37353 and 37349 and downgradient control for wells 37346 and 37347. The well also will provide information for assessing dilution effects as contaminant plumes migrate beneath the canals.
4. Well RI-11 will be useful in refining the configuration and extent of the DIMP plume in Section II. The location provides upgradient control for detections of DIMP, dieldrin, chloroform, and chlorobenzene in Study Area II.
5. Well RI-12 will provide information on contaminant migration along the Northern Paleochannel downgradient of O'Brian Canal, in an area of limited well control north of the Northern Paleochannel and northwest of the canals. The well also will provide data for assessing dilution effects as contaminant plumes migrate beneath the canals.

All new monitoring wells installed in Study Area II will be sampled twice under this task and will be evaluated for possible inclusion in the CMP. Wells will be sampled initially approximately two weeks after development and again after 8 to 10 weeks to verify initial results. Also, attempts will be made to sample a number of existing wells during the second sampling event to assess contaminant plume boundaries. The results will be evaluated and used in preparation of the RI Addendum.

2.5 SUMMARY OF FIELD AND ANALYTICAL PROCEDURES

The field procedures to be employed in implementing the sampling program are described in this section or in the Field Operations Plan (FOP) (HLA,1989b). The following sections describe procedures to be utilized for acquiring land access and permits and general procedures for ground-water, surface-water, soil, and biota sampling; decontamination and waste handling; sample tracking requirements; and analytical procedures. The FOP contains more detailed descriptions of procedures for drilling and borehole sampling, monitoring-well installation, and ground-water, surface-water, and soil sampling.

2.5.1 Land Access and Permit Requirements

The U.S. Army Corp of Engineers (COE) is responsible for negotiating access to private lands within the area of concern. The information presented in this section was collected to aid in identifying access needs to expedite negotiations for access rights. Additional information will be provided to the COE as needed.

Land access is critical to the timely completion of field activities because all land within the study area is privately owned or controlled by public utilities and will be subject to negotiations with these individuals and groups. Table 2.5-1 lists the names and mailing addresses of the owners-of-record of each proposed monitoring-well location. An access corridor 50 feet wide will be required to reach each monitoring-well location. The exact location of each proposed well will be determined in the field after permission for access is received. HLA will contact utility companies prior to field activities to obtain information about specific utility locations.

The actions proposed in this Work Plan are being undertaken pursuant to CERCLA, and must, to the maximum extent practicable, conform to Applicable or Relevant and Appropriate Requirements (ARARs). Federal, state, and local permits are not required for onsite response actions such as this, pursuant to CERCLA Section 121(e), 42 U.S.C. 9621(e). However, the Army will follow past practices and register the necessary information relating to well location and construction with the Office of the State Engineer.

Table 2.5-1: Owners of Record of Proposed Monitoring-Well Locations
in Study Areas Ia and II

<u>Proposed Well</u>	<u>Legal Description</u>	<u>Access Route</u>	<u>Owner and Mailing Address</u>
RI-1	Sec. 21 1700' FEL 45' FSL	From E. 88th Ave.	Adams County Highway Department Attn: Mr. Al Smith 4955 East 74th Avenue Commerce City, Colorado 80022 (303) 287-5249
RI-2	Sec. 21 2300' FEL 2150' FSL	West off Yosemite Proceed along O'Brian Canal	Burlington Northern Railroad Attn: Mr. Raymond Townsend 304 Inverness Way South Suite 200 Denver, Colorado 80112 (303) 799-2830
RI-4	Sec. 16 900' FEL 2300' FNL	From Union Pacific RR Parking Lot	Union Pacific Railroad Company Attn: Mr. Bob Jackson Omaha, Nebraska (402) 271-2331
RI-5	Sec. 15 700' FWL 2400' FSL	From the OSCO Plant Driveway	Oil & Solvent Process Company (OSCO) Attn: Bill Shortreed 9131 E. 96th Avenue Henderson, Colorado 80640 (303) 289-4827
RI-8	Sec. 16 650' FNL 50' FEL	From U.S. 85	Colorado Department of Highways Attn: Mr. Rudy Blea 5640 East Atlantic Place Denver, Colorado 80224 (303) 757-9901
RI-9	Sec. 15 1875' FNL 1075' FEL	From Havana along Burlington Ditch	Colorado Investor Realty Attn: Mr. Munir F. Ibrahim 3131 S. Vaughn Way, Suite 130 Aurora, Colorado 80014 (303) 337-3466
RI-10	Sec. 10 100' FSL 100' FEL	From I-76	Colorado Department of Highways Attn: Mr. Rudy Blea 5640 East Atlantic Place Denver, Colorado 80224 (303) 757-9901

Table 2.5-1: (Continued)

<u>Proposed Well</u>	<u>Legal Description</u>	<u>Access Route</u>	<u>Owner and Mailing Address</u>
RI-11	Sec. 11 2100' FWL 2600' FSL	E. 108th Avenue	Adams County Highway Department Attn: Mr. Al Smith 4955 East 74th Avenue Commerce City, Colorado 80022 (303) 287-5249
RI-12	Sec. 2 30' FSL 600' FEL	E. 112th Avenue	Adams County Highway Department Attn: Mr. Al Smith 4955 East 74th Avenue Commerce City, Colorado 80022 (303) 287-5249
RI-13	Sec. 21 875' FEL 675' FSL	From Yosemite	Glacier Park Company Attn: Barbara A. Smith 1200 17th Street, Suite 2600 Denver, Colorado 80202 (303) 572-6315
RI-14	Sec. 21 575' FEL 975' FSL	From Yosemite	Glacier Park Company Attn: Barbara A. Smith 1200 17th Street, Suite 2600 Denver, Colorado 80202 (303) 572-6315
RI-15	Sec. 22 2450' FEL 2450' FSL	From Highway 2	Colorado Department of Highways Attn: Mr. Rudy Blea 5640 East Atlantic Place Denver, Colorado 80224 (303) 757-9901
RI-16	Sec. 22 2050' FWL 1300' FNL	From Highway 2	Sam S. and Fannie H. Sigman K and B Partners 6265 E. Evans Avenue, Suite 201 Denver, Colorado 80222 (303) 691-2953
RI-17	Sec. 22 400' FWL 1450' FNL	From E. 96th Avenue along Burlington Ditch	Connecticut Mutual Life Insurance Company Attn: Mr. Bob Weisel 14 Garden St., M.S. 240 Hartford, Connecticut 06154 (203) 727-6500

Table 2.5-1: (Continued)

<u>Proposed Well</u>	<u>Legal Description</u>	<u>Access Route</u>	<u>Owner and Mailing Address</u>
RI-18	Sec. 21 750' FEL 2300' FNL	From E. 96th Avenue along Burlington Ditch	Burlington Ditch Company Attn: Mr. Harlan Wall Farmers Reservoir and Irrigation Company 80 South 27th Avenue Brighton, Colorado 80601 (303) 659-7373
RI-20	Sec. 16 75' FSL 1250' FEL	From E. 96th Avenue	Sinclair Marketing Inc. Attn: Mr. Jim Loving P.O. Box 30825 Salt Lake City, Utah 84130 (801) 524-2862
RI-21	Sec. 16 650' FEL 1200' FSL	From E. 96th Avenue	Sinclair Marketing Inc. Attn: Mr. Jim Loving P.O. Box 30825 Salt Lake City, Utah 84130 (801) 524-2862

2.5.2 Surveying

For each sampling location, the identification number, corresponding map coordinates and elevation, and date of measurement will be recorded in a field logbook. For each well or piezometer, the well number, date, map coordinates, and ground surface and casing elevations will also be recorded in the logbook. Boring and well locations will be surveyed by a Colorado registered surveyor. The data will be transmitted to PMRMA upon completion of the survey.

2.5.3 Water, Soil, and Sediment Sampling

2.5.3.1 Ground-Water Sampling and Water-Level Measurement

Prior to ground-water sampling, the field supervisor will ensure that all personnel have been fully trained in sampling and documentation procedures. All data collected during the ground-water monitoring program will be recorded on preprinted field data sheets and in bound field notebooks, as described in the Quality Assurance Plan (QAP) (HLA, 1989c).

Upon arrival at the sampling site, sampling personnel will use a photoionization detector (PID) to measure background and casing headspace concentrations and readings will be recorded. The above-ground casing height, depth to water, and total well depth will be measured and recorded. The decision to pump or bail a well will be made based on the relative efficiency of either method with respect to the amount of purge water to be removed. A minimum of five casing volumes will be removed from each well prior to sampling. Wells that dewater prior to the removal of five casing volumes will be exempt from these requirements. Sample bottles will be rinsed with well water prior to filling. The field team leader will sign and date the sample data sheet and complete the chain-of-custody record. All sample bottles will be placed on ice and stored at 4°C in a sample cooler immediately after filling. A complete description of the sampling procedures is described in the FOP, and the documentation and QA/QC requirements are provided in the Data Management Plan (DMP) (HLA, 1989d) and the QAP.

2.5.3.2 Surface Water

Surface-water sampling procedures will comply with those developed and employed under previous investigations. Surface-water samples will be obtained by integrating samples over the cross-sectional area of the stream. Where the stream is too small to permit this, samples will be collected from the center of the channel immediately below the stream surface. Stream gaging will be done or estimates of discharge will be made at each sampling location. Water samples from ponds will be collected as grab samples from points near the shoreline.

Surface-water samples will be collected with a stainless steel dipper, directly with the sample bottle, or with a spare clean sample bottle, as appropriate. All sample bottles will be placed on ice and stored at 4°C in a sample cooler immediately after filling. Complete details of surface-water sampling and preservation are included in the FOP. Documentation procedures are described in the DMP.

2.5.3.3 Subsurface Soils

The soil-sampling program will consist of one to two components. The first will include collecting samples at each boring location by driving an 18-inch lined split-barrel sampler to a depth of 12 inches. The second component, if required, will include continuous collection of samples from a depth of 1 foot to either the water table or to 5 feet, whichever is less.

Samples retained for analysis at each boring location will include the 0- to 1-foot depth interval and the 1-foot interval immediately above the water table or the 4- to 5-foot interval. Soil from the remaining sample liners will be extracted and placed in approved containers. All sampling equipment used during soil investigations will be decontaminated prior to use and between sampling locations as described in Section 2.5.6. In addition, split-barrel samplers and drive shoes will be decontaminated between sampling intervals.

For each sample collected, the field geologist will record the boring number, depth and time of collection, and percent recovery. Other observations will include weather, ground disturbances, soil discoloration, and site conditions.

2.5.3.4 Surficial Soils

Surficial soil samples will be obtained by collecting soil at each sampling location to a depth of approximately 2 inches from an area with an approximately 2-foot radius. The soil removed with a stainless-steel sampling scoop will be homogenized in a stainless-steel bowl and placed in 8-ounce glass containers with Teflon-lined lids. Collected samples will be placed on ice in insulated coolers. All sampling equipment will be thoroughly cleaned prior to use and between sampling locations in accordance with the established decontamination procedures. The HLA field geologist will document all observations and activities performed at each sampling location in a bound field notebook.

2.5.3.5 Stream and Pond Sediment

Sediment samples from streams and ponds will be collected utilizing procedures similar to those for collection of surficial soil samples. Sediment will be collected with a stainless-steel scoop from the upper 1 or 2 inches of the stream or pond bottom. The material collected will be placed in 8-ounce wide-mouth sample containers and will be stored on ice in insulated coolers. Site conditions, sediment characteristics, weather conditions, and other pertinent information will be recorded by the sampling team in a bound field notebook.

2.5.3.6 Biota Sampling

Sample collection, handling, and transport will be consistent with procedures previously developed for RMA, including those described in the CMP Biota Monitoring Technical Plan (RLSA, 1988a). When appropriate, biota sampling will be undertaken in consultation with the U.S. Fish and Wildlife Service representatives responsible for Arsenal wildlife management. In general, a combination of techniques will be employed for collecting biota samples depending on the species. For example, prairie dogs will be collected using either a shotgun (steel shot) or a .22 rifle and may also require the use of traps. Collection of pheasants also will likely require the use of a shotgun with steel shot. Other species, such as fish and grasshoppers will be collected using

various types and sizes of nets. In some cases, site-specific conditions will dictate the exact sampling procedure necessary and also may require slight modifications to the standard collection methods. The specific sampling procedures employed will be documented in field notebooks.

Biota samples may consist of several whole individuals, single individuals, or parts of a single organism. Composed or single whole organisms will be packaged as they are collected, except for earthworms, which will first be rinsed with deionized water to remove soil from the sample. Where parts of a single organism comprise the sample, the dissection will occur in the field to the extent possible. Any organisms still alive will be dispatched with ether or asphyxiated with carbon dioxide before samples are prepared. Samples will be handled only with decontaminated hands, cotton or leather gloves; rubber or plastic will not be allowed to contact the samples.

Samples will be placed in low-actinic glass jars or wrapped in two layers of hexane-rinsed aluminum foil, depending on their size and shape. Samples will be packaged immediately after they are dissected or, if necessary, first blotted with paper towel. If samples must be rinsed, they will be rinsed only with deionized water, then blotted and packaged. Foil wrapped packages may be placed in cardboard containers to protect the foil from puncture. In the field, samples will be placed in a cooler containing dry ice. Samples will be frozen (to approximately 4°C) before they are shipped to the laboratory. It is anticipated that samples will be shipped 24 to 48 hours after they are collected. Shipping will be in coolers containing dry ice sufficient to keep the samples frozen for two days, although the coolers will be shipped by overnight air freight. As each sample is wrapped and packaged, a sample tag and a chain-of-custody will be prepared from the field sheets prepared at the time of sample collection, and both will accompany that sample continuously.

2.5.3.7 Air

Procedures for sample collection, handling, and transportation to laboratories will be consistent with those described in the CMP Air Quality Monitoring Technical Plan (RLSA).

1988b). The exact procedures to be used will depend on the analytes expected, appropriate CRLs, and limitations of each sampling method. In general, the sampling procedure will employ the use of a sorbent to trap the volatile organic chemicals. The specific sampling procedures will be provided to the OAS prior to sampling.

2.5.4 Field Documentation and Sample Tracking

The FOP and DMP describe in detail the requirements for documentation of activities outlined in this Work Plan. All field personnel will be required to maintain a written record of their daily activities. All records will be written on prepared forms and will be signed and dated by all field personnel at the end of the day. Additional information will be recorded in a bound field notebook, which will be signed and dated each day, and will become a part of the project files.

Specific field documentation forms are provided for several different activities. Information relating to water-level measurements will be recorded on a "Water-Level Measurement" form. All ground-water and surface-water sampling information will be recorded on a "Ground-Water Sampling" form. The drill site geologist will maintain a "Record of Activities" at the drill site, which is a time record of all drilling site activities and personnel. A "Field Log of Boring" form will be used by the geologist for descriptions of all samples collected. Information relating to boring abandonment will be recorded on both forms described above. Completion and well development information for all wells or piezometers will be recorded on a "Field Well Completion" form. Sample labels and chain-of-custody forms for all analytical samples also will be completed. Examples of these forms are provided in the FOP and DMP.

2.5.5 Accident Prevention and Safety Program

The Health and Safety Plan (HSP) prepared for the RIFSI investigation (HLA, 1989e) describes health and safety aspects of field operations. The HSP provides detailed information relative to the site, hazard analysis, risk assessment, procedures to mitigate hazards, action levels,

site control, personal protective equipment (PPE), and emergency information. The HSP sets forth procedures for preparation of field equipment and performance of sampling and measurement tasks to be conducted in compliance with the PMRMA Chemical QA Plan (PMRMA, 1989).

2.5.6 Decontamination and Waste Handling

The FOP describes in detail the requirements for decontamination and waste handling for activities outlined in this Work Plan. Field activities to be performed in implementing this Work Plan that may result in waste generation include drilling, monitoring-well installation, well development, and ground-water sampling from new and existing monitoring wells. Each of these investigative activities will generate waste materials that may be considered contaminated and will therefore require handling as such. As described in the FOP, the objective of the waste handling program is to standardize procedures for waste characterization, inventory, storage, management, and disposal of all potentially hazardous wastes generated during the investigative activities. Although field investigations at RMA may generate a large volume of potentially contaminated soil and water, contaminants are not detectable in all of this material. To avoid unnecessary handling, storage, and disposal of nonhazardous waste materials, contractors at RMA have established a waste handling program in conjunction with PMRMA and EPA (EPA, 1985).

Procedures for handling water generated during decontamination, well development, or well evacuation in conjunction with water-quality monitoring will be consistent with the procedures currently followed at RMA (EPA, 1985). These procedures will reduce inefficient use of labor caused by lack of coordination of decontamination and wastewater disposal needs and schedules.

Equipment used for drilling, soil or water sampling, and well installation, including well materials (e.g., casing) will be thoroughly decontaminated prior to use, as described in Section 14.0 of the FOP. Well materials will be steam cleaned at the Section 36 decontamination pad, allowed to air dry, wrapped in plastic, and stored until use. Field decontamination of equipment will be accomplished using a trailer-mounted portable steam cleaner and a clean water tank filled with COR-approved water. All rinse water will be containerized during field decontamination.

2.5.7 Analytical Program

The QAP presents the policies, organization, objectives, functional activities, and QA activities associated with this investigation. The QAP was prepared to ensure that data generated are accurate, precise, complete, comparable, and representative of actual field conditions. The list of target analytes for the investigation described in this Work Plan is shown in Table 2.5.2. Target analytes were selected on the basis of previous RMA investigation target analyte lists, with minor additions. All analytical activities will be performed in accordance with the PMRMA Chemical QA Plan and the QAP. Standard PMRMA-certified methods will be utilized whenever possible unless otherwise specified by HLA. Nonstandard methods such as biological oxygen demand (BOD) or ammonia nitrogen analyses, which do not require certification, will be performed using standardized EPA methods shown on Table 2.5-2. In all cases, the analytical methods to be employed will be selected to provide, to the maximum extent practicable, the lowest certified reporting limit threshold while maintaining the highest possible degree of analytical reliability. Site conditions, chemical characteristics of target analytes, and the complexity of the sampling media will be considered prior to selecting the method or methods to be used. The objectives of the study will also be considered prior to each sampling event so that the methods selected are appropriate to meet these goals. Containers, preservatives, storage conditions, and holding times are specified in the QAP.

The laboratory to be used during each phase of a sampling program will be selected after availability has been determined and the turnaround time objective has been defined. Certified reporting limits for each certified method and the selection criteria discussed above also will be considered in the final selection process.

Quality assurance reports to monitor the analyses and performance of QC samples or performance criteria stipulated by the PMRMA Chemical QA Plan will be generated on a demand basis by the HLA Quality Assurance Coordinator in conjunction with the Laboratory Quality Assurance Coordinator and PMRMA. A detailed description of the QA reporting procedures, QC

Table 2.5-2: RMA Method Target Analyte List

	Ground Water/ Tap Water	Surface Water	Soil; Stream and Pond Sediment		Surficial Soil	Biota	Method*
Volatile Organic Compounds							
1,1-Dichloroethane							GC/CON/GC/MS
1,2-Dichloroethane	x		x	x			GC/CON/GC/MS
1,1-Dichloroethene	x		x	x			GC/CON/GC/MS
1,1,1-Trichloroethane	x		x	x			GC/CON/GC/MS
1,1,2-Trichloroethane	x		x	x			GC/CON/GC/MS
Benzene	x		x	x			GC/PID/GC/MS
Bicycloheptadiene	x		x	x			GC/CON/GC/MS
Carbon tetrachloride	x		x	x			GC/CON/GC/MS
Chlorobenzene	x		x	x			GC/CON/GC/MS
Chloroform	x	x	x	x	x		GC/EE/GC/MS
Dibromochloropropane	x	x	x	x	x		GC/FID/GC/MS
Dicyclopentadiene	x	x	x	x	x		GC/FPD/GC/MS
Dimethyl disulfide	x	x	x	x	x		GC/PD/GC/MS
Ethylbenzene	x	x	x	x	x		GC/PD/GC/MS
m-Xylene	x	x	x	x	x		GC/CON/GC/MS
Methylene chloride	x	x	x	x	x		GC/FID/GC/MS
Methyl isobutyl ketone	x	x	x	x	x		GC/PD/GC/MS
o,p-Xylene	x	x	x	x	x		GC/CON/GC/MS
Tetrachloroethene	x	x	x	x	x		GC/PD/GC/MS
Toluene	x	x	x	x	x		GC/CON/GC/MS
1,2-Dichloroethene	x	x	x	x	x		GC/EE/GC/MS
Trichloroethene							
Vinyl chloride	x	x	x	x	x		
Semivolatile Organic Compounds/Pesticides							
1,4-Oxathiane	x	x	x	x	x		GC/FPD/GC/MS
p,p'-DDE	x	x	x	x	x		GC/EE/GC/MS
p,p'-DDT	x	x	x	x	x		GC/EE/GC/MS
Aldrin	x	x	x	x	x		GC/CONPD/GC/MS
Atrazine	x	x	x	x	x		GC/FPD/GC/MS
Benzothiazole	x	x	x	x	x		GC/EE/GC/MS
Chlordane	x	x	x	x	x		GC/FPD/GC/MS
Chlorophenyl(methyl sulfide	x	x	x	x	x		GC/FPD/GC/MS
Chlorophenyl(methyl sulfoxide	x	x	x	x	x		GC/FPD/GC/MS
Chlorophenyl(methyl sulfone	x	x	x	x	x		GC/EE/GC/MS
Dieldrin	x	x	x	x	x		GC/FPD/GC/MS
Disopropylmethyl phosphonate							

Table 2.5-2: (Continued)

	Ground Water/ Tap Water	Surface Water	Soil; Stream and Pond Sediment	Surficial Soil	Biota	Method*
Semivolatile Organic Compounds/Pesticides (continued)						
Dimethylmethylphosphonate	x	x	x	x	-	GCFFD/GCMS
Dithiane	x	x	x	x	-	GCFFD/GCMS
Endrin	x	x	x	x	x	GCE/GCMS
Hexachlorocyclopentadiene	x	x	x	x	x	GCE/GCMS
Isodrin	x	x	x	x	x	GCE/GCMS
Malathion	x	x	x	x	x	GCNPD/GCMS
Parathion	x	x	x	x	x	GCNPD/GCMS
Supona	x	x	x	x	x	GCNPD/GCMS
Vapona	x	x	x	x	x	GCNPD/GCMS
Phenol	x	x	x	x	x	GCFID/GCMS
2-Chlorophenol	x	x	x	x	x	GCFID/GCMS
2-Nitrophenol	x	x	x	x	x	GCFID/GCMS
2,4-Dimethylphenol	x	x	x	x	x	GCFID/GCMS
2,4-Dichlorophenol	x	x	x	x	x	GCFID/GCMS
4-Chloro-3-methylphenol	x	x	x	x	x	GCFID/GCMS
2,4,6-Trichlorophenol	x	x	x	x	x	GCFID/GCMS
2,4-Dinitrophenol	x	x	x	x	x	GCFID/GCMS
4-Nitrophenol	x	x	x	x	x	GCFID/GCMS
4,6-Dinitro-2-methylphenol	x	x	x	x	x	GCFID/GCMS
Pentachlorophenol	x	x	x	x	x	GCFID/GCMS
Inorganics/General Characteristics						
Cadmium	x	x	x	x	x	ICP
Calcium	x	x	x	x	x	ICP
Chromium	x	x	x	x	x	ICP
Copper	x	x	x	x	x	ICP
Sodium	x	x	x	x	x	ICP
Lead	x	x	x	x	x	ICP
Magnesium	x	x	x	x	x	ICP
Potassium	x	x	x	x	x	ICP
Zinc	x	x	x	x	x	EPA-206
Arsenic/AA	x	x	x	x	x	EPA-245
Mercury/AA	x	x	x	x	x	EPA-335.1
Total amenable cyanide	x	x	x	x	x	EPA-405.1
Biological Oxygen Demand	x	x	x	x	x	

Table 2.5-2: (Continued)

	Ground Water/ Tap Water	Surface Water	Soil, Stream and Pond Sediment		Surficial Soil	Biota	Method*
Inorganics/General Characteristics (continued)							
Sulfide	-	-	x	-	-	-	EPA-376.2
Ammonia nitrogen	-	-	x	x	-	-	EPA-350.1
TOC	x	x	x	x	-	-	EPA-415.2
Alkalinity	x	x	x	x	-	-	EPA-300
Nitrate/Nitrite	x	x	x	x	-	-	EPA-300
Sulfate	x	x	x	x	-	-	EPA-300
Chloride	x	x	x	x	-	-	EPA-300
Fluoride	x	x	x	x	-	-	EPA-150.1
pH	x	x	x	x	-	-	EPA-120.1
Specific conductance	x	x	x	x	-	-	EPA-170.1
Temperature	x	x	x	x	-	-	EPA-360.2
Dissolved oxygen	-	-	-	-	-	-	-

Abbreviated Method Name Descriptions:

AA - Atomic Absorption Spectroscopy
 GC/CON - Gas Chromatography/Conductivity Detector
 GC/EC - Gas Chromatography/Electron Capture
 GC/FID - Gas Chromatography/Fame Ionization Detector
 GC/FPD - Gas Chromatography/Fame Photometric
 GC/MS - Gas Chromatography/Mass Spectrometry
 GC/NPD - Gas Chromatography/Nitrogen Phosphorous Detector
 GC/PID - Gas Chromatography/Photoionization Detector
 ICP - Inductively Coupled Argon Plasma

* Methods to be employed for the analyses of program sampling media will be determined using the following criteria: (1) desired certified reporting limit (CRL) to meet program and PMRMA requirements; (2) effectiveness of the method in analyzing a sampling medium; (3) availability of a certified method to analyze a sample medium; and (4) need to confirm GC results using GC/MS

sample requirements, and performance criteria established in the PMRMA Chemical QA Plan are provided in the QAP. The contractor laboratories will be responsible for informing HLA of QC problems that occur during the analyses. HLA, in conjunction with PMRMA, will inform the laboratory of the corrective action that will be taken. Laboratories will be required to meet all PMRMA QC criteria. No samples will be analyzed beyond the prescribed holding times or using an uncertified method unless prescribed by HLA.

2.6 RI ADDENDUM REPORT

Evaluation of the data collected for the RI addendum will focus on meeting the following objectives:

1. Assess the lateral extent of contaminant plumes in ground water in which an inadequate number of wells were originally installed near the perimeter of the plumes.
2. Assess the potential ground-water migration pathways in areas where well control will be refined.
3. Assess migration pathways in media not previously considered.

All data collected will be processed in accordance with the DMP and as described in Section 2.5.4 of this document. The data will be presented as an addendum report to the Final RI Report and will be utilized in preparation of the revised Draft Final EA/FS Report.

The addendum will include a description of the data collection and sampling procedures for the media being evaluated, either in detail or by reference to the FOP. The data collection locations and analytical results of the sampling will be reported in tables and illustrations, as appropriate. Other data, such as borehole logs and monitoring-well schematic diagrams, also will be included in an appendix. The significance of the results will be evaluated and discussed in the report, and the relationships between different media and pathways will be evaluated.

3.0 REVISION OF THE ENDANGERMENT ASSESSMENT

The EA for the Offpost OU will be revised in accordance with relevant EPA guidance. The EA portion of the EA/FS Report will be revised in response to comments made by the OAS and to incorporate additional data, as discussed in Section 2.0 of this Work Plan. New data will necessitate changes in exposure estimation procedures and inclusion of additional contaminant pathways.

Documentation of the indicator chemical selection process will be revised to incorporate new data on additional contaminated media and will be enhanced in response to OAS comments. Guidance documents and technical reports that have become available since the Draft Final EA/FS Report was prepared will be considered in the revision process. Toxicity assessments will be updated to reflect recent developments in the literature and will be revised in response to OAS comments.

The risk characterization will provide information on several topics that had been preliminarily screened as having little substantive impact on the remedial decision process. These topics include the potential noncarcinogenic effects of carcinogenic contaminants and the effects of subchronic exposures.

Potentially sensitive human subpopulations will be identified based on readily available information from appropriate public agencies. Information also will be presented on the distribution of nonhuman receptors in the Offpost OU, and additional documentation will be provided regarding the selection of indicator species for ecological risk assessment.

The technical issues raised by some reviewers of the Draft Final EA/FS are sufficiently complex that additional discussions, evaluation, and/or research will be needed to further evaluate and resolve the issues. To address such issues, PMRMA will establish technical working groups that focus on specific issues. One or more meetings may be required to resolve some issues, and others may be resolved by oral or written communications. The OAS will be informed of the establishment and objectives of these working groups, and subsequent participation by any

organization would be voluntary. Specifically, working groups will address the following unresolved issues: (1) reference doses for livestock, (2) the basement/volatilization model, (3) the scope and objectives of the uncertainty analysis, and (4) the exposure estimation procedure (Preliminary Pollutant Limit Value (PPLV) equations).

3.1 96th AVENUE RISK ASSESSMENT

Because the area immediately north of RMA is a rural residential area, it is likely that the maximally exposed individual for this assessment would be a hobby farmer residing in a portion of Study Area Ia near the intersection of 96th Avenue and Peoria Street. This represents an existing land use and lifestyle in the subject area. Both the observed contaminant distribution and the potential for exposure to RMA contaminants as a result of activities associated with this lifestyle support the conclusion that this scenario represents maximal exposure. Residents of this area will be interviewed to better define their activities and utilizations of locally grown foods. Results of this survey will be used to supplement published national and regional data to define exposure rates for this scenario.

During the last 12 months additional data regarding the concentration of RMA indicator chemicals in environmental media not previously sampled in the Offpost OU have become available as described in Section 2.0. These include surficial soil samples, a limited set of samples from various agricultural animals, and additional samples from First Creek, including sediments and fish. These data will be further evaluated as a basis for estimating chronic exposure concentrations.

Based on available information, alluvial ground water is not used for potable or agricultural use in this limited area at this time, principally because it is known to be contaminated and alternative water supplies are being used. The land is not intensively irrigated because of the unavailability of surface irrigation water, a condition unrelated to the alluvial contamination. Based on historical water use patterns, use in adjacent uncontaminated areas, and the resident interviews, the exposure scenario for the maximally exposed individual may include exposure to

alluvial ground water from uses that are not presently occurring. A separate estimate of existing exposures (excluding alluvial ground water) also will be developed.

Appendix A contains a detailed discussion of the technical approach and schedule for performing the 96th Avenue Risk Assessment.

Pathways to be considered in this assessment include:

1. Direct exposure to soil contaminants through incidental ingestion, inhalation of reentrained dust, and dermal absorption;
2. Contamination of foodstuffs such as meat, dairy products, eggs, fruits and vegetables after uptake from soil, irrigation water, or air;
3. Exposure to RMA contaminants in ambient air;
4. Exposure to sediments via dermal absorption, and incidental ingestion;
5. Exposure to game meat, specifically pheasant.

3.2 REEVALUATE CONTAMINANTS OF CONCERN AND INDICATOR CHEMICALS

In response to OAS comments, consistency with the Superfund Public Health Evaluation Manual (SPHEM) indicator chemical selection process will be demonstrated by additional documentation. Additionally, currently available EPA guidance published subsequent to SPHEM also will be considered, as appropriate. In particular, the indicator scores will be presented by contaminant and medium. The availability of additional data from media not previously sampled also will dictate re-evaluation of the indicator chemical selection. Current information from the Integrated Risk Information System (IRIS) database and the revised Toxicity Assessment Report will be used in the selection process. The indicator chemicals will be selected on the basis of data available at the early stage of the EA revision process. The selection process will take into consideration recently received information from CDH regarding indicator chemicals for the offpost OU. To the extent that subsequent information may have altered the chemicals selected, such deviations will be discussed in the EA portion of the revised report.

3.3 REEVALUATION OF TOXICITY ASSESSMENTS

The OAS presented comprehensive and detailed comments on the toxicity assessment. Many of these comments will require additional evaluation by PMRMA. Resolution of some issues will probably require additional communications with the OAS. A wide range of perspectives were presented. For example, a number of different approaches have been expressed by the OAS as being appropriate for defining reference doses for livestock. To fully evaluate these inputs, PMRMA will establish a technical working group to obtain additional technical input from the OAS. The OAS will be informed of the establishment of this working group shortly after implementation of this Work Plan is initiated and will be invited to participate.

As in any site-specific risk assessment, the Offpost OU EA is not an appropriate context for conducting generic toxicological research or reevaluating fundamental toxicological issues that are more appropriately addressed through national and international programs. Many of the comments received from the OAS have previously been presented to EPA in the context of national standards and criteria development. These comments have been evaluated by the government in these broader contexts, and EPA's position is represented by published dose response assessments. In addition, many of the comments are similar, if not identical, to comments presented to the Army during development of the (onpost) Toxicity Assessment Report, and the Army's response is incorporated in that report. Issues previously addressed will not be re-evaluated here unless new data or recent changes in EPA policy would affect the Army's conclusions.

3.4 FATE AND TRANSPORT ASSESSMENT

All aspects of the fate and transport assessment will be reviewed in light of new data to be reported in the RI addendum. Some major topics, listed below, will be reevaluated in the revised EA, based on current information and comments by the OAS on the Draft Final EA/FS:

1. Mechanisms and source-receptor relationships for contamination of surficial soils in the Offpost OU

2. The examination of potential migration pathways that may possibly impact Barr Lake
3. Prediction of inhalation exposures as a result of volatilization from ground water

Recently available data indicate that surficial soils in the Offpost OU near the north boundary of RMA contain chemicals associated with RMA at levels that may exceed ambient background. The source of these contaminants has not been fully assessed. The sampling program outlined in Section 2.0 is expected to yield additional information to allow conclusions to be drawn regarding the source of these contaminants and the transport mechanisms. Surficial soil samples will be collected both onpost and offpost. The spatial patterns exhibited by resulting data should be conclusive regarding the importance of airborne pathways and of specific sources of air emissions, past or present. If additional useful information can be obtained from an atmospheric dispersion and deposition model, perhaps to support extrapolation beyond the existing sampling area, a standard model will be applied.

OAS comments indicated that conclusions drawn in the Draft Final EA/FS Report regarding the impact of RMA sources on Barr Lake were imprecisely stated and inadequately supported by the information presented. Additional data will be collected to further assess transport pathways from RMA sources to Barr Lake (see Section 2.0). Conclusions will be re-evaluated in light of these data, and additional discussion will be provided to support the conclusions in the revised Draft Final EA/FS Report, if they remain valid.

Finally, an OAS technical working group will evaluate new information and potentially revise the fate and transport model used in the EA to estimate inhalation exposures in buildings above areas of ground water contaminated by volatiles.

3.5 EXPOSURE ASSESSMENT

The PPLV methodology will be used to support exposure and risk estimation in the EA/FS Report revision. Each member of the OAS, however, commented on the specific application of the methodology in this assessment. Numerous comments were received on the derivation of the PPLV equations that were used and the definition of the input parameters, such as physiological

parameters, food and water intake rates, and equilibrium partitioning coefficients. Some of the PPLV equations may be modified, and additional pathways may be modeled to reflect and/or better utilize the additional data that will be presented in the RI addendum. To respond to the comments and to effect better communication with the OAS prior to completion of the assessment, the Army will present the proposed PPLV equations to the OAS via a memorandum to be discussed at a subsequent meeting with the OAS. The Army's response to comments on input parameters will also be discussed at a meeting. This interaction is similar to other technical working groups; however, because each member of the OAS had substantial interest in this topic and the technical working group would have broad representation, it would be most efficient to discuss this topic at a meeting in which each member of the OAS was represented.

Rewvisions to the EA, consistent with EPA guidance, will include development and presentation of additional information on the distribution of sensitive human and nonhuman receptors. A habitat/land use map for Study Area Ia will be prepared as well as an inventory of aquatic biota in surface waters in that area. Institutions in the Offpost OU, such as hospitals, nursing homes, and schools, which may house or attract sensitive individuals, will be identified as described earlier in this section. These data will be used with census information to determine whether the Offpost OU includes an unusually high percentage of potentially sensitive receptors. If so, this will be reflected in the risk characterization. Recent changes in guidance on developmental toxicants will also be considered in the risk characterization.

As previously discussed, comments by the OAS on exposure assumptions and input parameter values for the PPLV analysis will be reviewed in detail and addressed in subsequent communications with the OAS.

3.6 RISK CHARACTERIZATION FOR HUMAN HEALTH ANALYSIS

The revised Draft Final EA/FS Report will address several topics that were not discussed in detail in the Draft Final EA/FS Report. The potential noncarcinogenic effects of carcinogenic contaminants will be evaluated. The previous assessment, based on guidance from the Endanger-

ment Assessment Subcommittee, had considered that such effects occur only at exposure concentrations that would be unacceptable based on the carcinogenic risk assessment. Under this assumption, these effects will have little import to the remedial decision-making process. It is the Army's current position that such effects should not be ruled out at anticipated exposure concentrations and they will thus be discussed.

A subchronic exposure scenario, appropriate to childhood or youth, will be defined, and risks from less than lifetime exposures will be characterized. As discussed in Section 3.5, exposure of sensitive subpopulations will be reviewed in the context of recently published information on developmental toxicants. If census data or the planned inventory of institutions indicate an unusual concentration of potentially sensitive individuals, the risk characterization will specifically identify the potential for adverse health effects.

A technical working group will be established to consider comments by Shell that the scope of the uncertainty analysis should be expanded to consider uncertainty in the dose response information in addition to uncertainty in the exposure estimates.

4.0 REVISION OF FEASIBILITY STUDY

The revised FS will use a methodology similar to that presented in the initial version of the Draft Final EA/FS Report. Although recent EPA guidance will require minor modifications in the FS development, the revised document will consist of the same major components, including (1) evaluation of ARARs and development of RAOs, (2) identification and screening of technologies, (3) development and screening of alternatives, and (4) detailed alternatives analyses and selection of a preferred alternative. The effort for revising the FS will focus on providing the framework for work not performed in the original study. The anticipated scope of work generally falls into the following three categories:

1. Evaluation of alternatives for media that were not assessed in the original report but that may require evaluation based on the revised EA
2. Evaluation of alternatives for study areas that were not previously assessed but for which alternatives analyses may be appropriate based on the revised EA
3. Revision of the development of alternatives based on specific comments from the OAS and the inclusion of more recent EPA guidance

The following discussion briefly addresses the major work tasks of the FS and emphasizes the three categories of expected modification outlined above.

4.1 ALTERNATIVES EVALUATION FOR DIFFERENT MEDIA

Perhaps the most critical portion of the FS revision will be to assess whether an alternatives analysis is required for offpost media not considered in the Draft Final EA/FS Report. Continual interaction will be maintained between EA and FS staff to ensure that decisions to proceed with evaluations for different media are made at the earliest possible date. The schedule for the revised Draft Final EA/FS Report dictates that these decisions be made prior to finalizing the EA. Although no formal report will document these decisions, the OAS will be advised of these decisions through routine working sessions. Information, as described below, will be evaluated to determine the necessity of conducting alternative assessments for each potentially affected medium in the Offpost OU.

4.1.1 Surficial Soil

Analytical data were not available for surficial soils in the Offpost OU at the time the Draft Final EA/FS Report was prepared. Since that time, surficial soils have been collected and analyzed from the offpost area immediately north of 96th Avenue, as described in Section 2.0. Additional surficial soil sampling and analyses, including an investigation of background concentrations, is planned for the Offpost OU. These data will be the basis for evaluating potential endangerment in the revised EA and for determining whether an alternatives analysis is required in the FS. As with the other media, a decision to proceed with an alternatives analysis for surficial soil will be made prior to finalization of the EA, and the OAS will be notified through periodic working sessions.

The development of alternatives for remediating surficial soils also will largely depend on the establishment of migration pathways. At present, it is suspected that OCP contamination may have resulted from windblown deposition, offpost irrigation, domestic and agricultural uses, surface flooding, or combinations of these pathways. The relative contribution from each pathway, however, is not known. It is anticipated that the assessment of onpost surficial soil data will be pivotal in delineating migration pathways. Thus, these data will be factored into the offpost FS to ensure that alternatives address not only existing offpost contamination but also the probable sources of contamination to the fullest extent possible. It is possible, therefore, that recommendations for onpost actions may be an integral part of the alternatives for this medium.

4.1.2 Surface Water and Sediment

Both surface water and stream sediments were evaluated in the Draft Final EA/FS, but these evaluations were based on a relatively limited data base. Since the issuance of the Final RI Report, additional surface-water and sediment sampling and analyses have been performed, as described in Section 2.2.2. These data indicated that the nature and concentration levels of contaminants in both media differed somewhat from that presented in the Final RI Report.

Because of the existence of more recent data, the EA portion of the EA/FS Report will be modified to reassess these media. Depending on the results of the EA, remedial alternatives for these media may need to be assessed in the FS. It is anticipated that decisions concerning these media will be made during the preliminary stages of revising the EA and will be discussed with the OAS in routine working sessions.

4.1.3 Air and Biota

Offpost air-quality data were not available at the time the initial version of the Draft Final EA/FS Report was prepared, although this was not considered necessary because onpost data did not indicate a potential problem. Since that time, extensive air-quality monitoring has been conducted by the Army at the RMA boundaries and, to a limited extent, in the Offpost OU. These data have been collected under the CMP and the Basin F IRA and, as indicated previously, will be evaluated by the EA. If the EA indicates that endangerment from offpost air contamination exists and is related to onpost sources, alternatives formulated for this medium may include onpost source control. Under exposure scenarios in which sources are offpost, such as the possible upward migration of volatile organics from ground water into underground structures, the remedial action alternatives will be specific to the offpost area.

Offpost biota data were extremely limited at the time the Draft Final EA/FS Report was generated. Thus, the need for remedial actions for biota will be based on data collected under activities described in this Work Plan and existing onpost data, including information on population and migration habits. As with air and surficial soils, remedial actions for biota may involve both onpost and offpost actions, depending on the biota affected and the exposure pathways.

4.2 EVALUATION OF ARARs AND DEVELOPMENT OF REMEDIAL ACTION OBJECTIVES AND GENERAL RESPONSE ACTIONS

The evaluation of ARARs and development of RAOs will follow the same general process used in the Draft Final EA/FS Report. Two specific areas of revision are anticipated. The first

involves an evaluation of ARARs and the development of RAOs for media identified in the revised EA as posing an endangerment to human health or the environment but which were not assessed in the Draft Final EA/FS Report. Second, because effects from these media may be additive to those pathways considered in the Draft Final EA/FS Report, the inclusion of other media may result in revisions to the final RAOs for ground water.

The RAOs will consist of medium-specific and study area-specific goals for protecting human health and the environment. In general, the RAOs will specify the contaminant of concern, the exposure route and probable receptors, and an acceptable concentration range or range of levels for each exposure route. RAOs for protecting human health will express both a contaminant level and an exposure route rather than contaminant levels alone because protectiveness may be achieved by reducing exposure as well as by reducing contaminant levels.

Of primary importance to the revised FS will be the development of preliminary RAOs early in the EA/FS process. These preliminary RAOs will be used to examine the potential for endangerment of human health and the environment and the necessity of conducting alternative analyses for different media. The preliminary RAOs will be established on the basis of readily available information, such as reference doses and ARARs. Because of the importance of the preliminary RAOs to the decision-making process in the FS, RAOs will be a major topic of discussion in working sessions with the OAS.

Final RAOs will be developed from ARARs and risk-based levels derived in the EA. As in the Draft Final EA/FS Report, RAOs may differ between study areas because of variation in the types and magnitude of contaminant exposures. Consistent with guidance, ARARs will be evaluated for protectiveness in specific cases in which EPA has deemed that they may not be protective of human health and the environment. In addition to conditions addressed in the Draft Final EA/FS Report, multimedia effects will be considered in evaluating protectiveness and in formulating the final RAOs.

General response actions will be formulated concurrent with the identification of RAOs. These actions are medium-specific actions that will satisfy RAOs and may include treatment,

containment, excavation, extraction, disposal, institutional actions, or a combination of these. Formulating these response actions at this point in the FS process facilitates the screening of technologies and process options, which is discussed in the next section. This information will be provided in tabular form for ease of use in the screening stage.

4.3 TECHNOLOGY AND PROCESS OPTION INVENTORY AND SCREENING

The emphasis of the technology inventory and screening (TIS) portion of the revised FS will be identifying and selecting technologies and process options most appropriate for remediating contamination in media not addressed by the Draft Final EA/FS Report. Technologies will be identified and screened for the general media categories of water, soil, air, and biota, if endangerment is indicated for these media. Although a TIS may be conducted for all these media, it may not be applicable to every study area. It is expected that the TIS information in the Draft Final EA/FS Report will satisfy most of the needs for ground water and perhaps surface water. Additionally, the results of the TIS conducted for the onpost FS and the Onpost Final TIS (ESE, 1988b) are expected to provide necessary information for some of the media.

The screening of technologies and process options will be used to develop a list of applicable technologies and process options for each study area in the Offpost OU. An applicable technology, either independently or in combination with other technologies, provides for a reduction in the mobility, toxicity, or volume of contamination. The first step of the two-step screening process will be to eliminate technologies and process options not compatible with the general conditions in the Offpost OU. The second step will be to refine the initial inventory list of screened, applicable technologies and process options by considering the compatibility of technologies with the specific characteristics of each study area.

Technology and process option screening will utilize the three general criteria of site characteristics, material/contaminant characteristics, and technological limitations. Site characteristics that will be evaluated include hydrologic and geologic conditions and the general configuration of the area to be remediated. Material/contaminant characteristics of importance

include physical state, quantity, concentration, chemical composition, and (perhaps most importantly) treatability. Technological limitations are also considered when screening technologies and process options. Such factors as implementability and operation and maintenance requirements will be the primary factors considered when addressing these criteria. Either of these factors may render a technology inappropriate unless the technology is considered innovative, in which case these criteria are not applied.

Before developing alternatives, the technology process options considered implementable will be evaluated in greater detail before selecting one process to represent each technology type. One process will be selected for each type of technology to simplify the development and assessment of alternatives. The representative process provides a basis for developing performance specifications during preliminary design although the option of selecting a different process during remedial design is retained to allow greater flexibility at the design stage.

4.4 DEVELOP REMEDIAL ALTERNATIVES

Alternatives for media not addressed in the Draft Final EA/FS Report will be developed in a manner similar to those developed for ground water. In general, a wide range of alternatives for each medium identified to be of concern by the EA will be developed. The alternatives will be evaluated and screened to reduce the number of alternatives carried forward to the detailed evaluation step. After screening, medium-specific alternatives will be combined to formulate comprehensive alternatives for remediation of each study area in the Offpost OU. A detailed evaluation of these comprehensive alternatives will be conducted to select the most appropriate overall remedy. The development, screening, and detailed evaluation of alternatives are described in more detail in the following sections.

4.4.1 Development and Screening of Alternatives

Remedial alternatives representing a range of actions will be developed for each medium from response actions and representative technologies. Remedial alternatives will span a range from "no action" to "no further action required after remediation" and will include a containment

option with little or no treatment, when possible. Alternatives will be developed by combining representative process options from different technology types to address RAOs. Using these technologies, alternatives that reduce toxicity, mobility, or volume as a principal element and provide permanent solutions, treatment technologies or recovery technologies, will be developed to the maximum extent possible. At this stage, order-of-magnitude estimates of volume or flow rates of contaminated material will be considered to develop feasible alternatives.

Screening of medium-specific alternatives will be performed to narrow the list of potential alternatives that will be assessed in the detailed evaluation phase. The screening allows for efficient progress of the FS while ensuring that the most promising alternatives are retained for consideration. The screening will evaluate the alternatives against the three criteria of effectiveness, implementability, and cost to eliminate alternatives that are not protective of human health or the environment or are significantly more costly than other alternatives. The screening will be performed before multimedia alternatives are formulated to simplify the analyses of the comprehensive alternatives developed for the different study areas.

Alternatives with the most favorable composite evaluation of all criteria will be retained for further consideration in the detailed analysis. The alternatives selected for further evaluation will, where practical, preserve the range of treatment and containment alternatives developed. It is not required, however, that the entire range of alternatives originally developed be preserved if all the alternatives in a portion of the range are not viable alternatives. Alternatives that use innovative technologies, such as the in-situ biodegradation alternative for OCP-contaminated ground water presented in the Draft Final EA/FS Report, will be carried through the screening process if they offer a potential for better treatment performance or implementability, lower cost, or fewer or less adverse impacts than other available alternatives.

4.4.2 Formulation of Multimedia Alternatives

The screened medium-specific alternatives will be assembled into comprehensive alternatives that provide a broad range of remedial action for the Offpost OU. These alternatives will

range from "no action" to "no further action needed after remediation." The alternatives developed will be specific to the study areas in the Offpost OU. At this stage of the FS, more detailed information on site-specific characteristics that will affect detailed evaluation in each study area will be factored into the alternatives. This will include information on characteristics such as flow rates or volumes of contaminated media, which are specific to each study area in the Offpost OU. As stated previously, it is anticipated that alternatives for some media will be evaluated for certain study areas and not for others. These determinations will be based on the additional data being collected and the revised EA.

Another important aspect of this portion of the FS will be the development of the Final RAOs, which consider multimedia effects. Formulation of these values will be based on an examination of ARARs and health-based levels that will be developed in the EA for each study area. The final RAOs will be fundamental in providing the basis for comparing the effectiveness of alternatives in the detailed evaluation of alternatives.

4.4.3 Detailed Analysis of Alternatives

The detailed analysis of alternatives will be the final step in the FS leading to the selection of a remedy for each study area. As stated in the Draft Final EA/FS Report, a separate alternative analysis will be performed for each study area. The ultimate goal of these analyses is to provide enough detail to provide defensible documentation for the selection of preferred alternatives and to prepare and finalize the Record of Decision (ROD).

Alternatives will be refined at this stage to ensure that cost estimates with the desired accuracy (+50 percent to -30 percent) can be obtained for each alternative. Refinements to the alternatives will include items such as (1) more accurate estimates of volumes and flow rates based on data in the RI addendum, (2) changes in the sizing of specific processes, and (3) possibly the selection of different representative process options, based on treatability studies being performed in the RMA RIFS4 Task. In general, the information developed to refine

alternatives at this stage may be used for preliminary design calculations, process flow diagrams, sizing of major treatment units, site layouts, and discussion of assumptions and uncertainties.

The evaluation criteria for the alternatives analysis recommended by EPA have been modified somewhat since the initial Offpost RI/EA/FS Technical Plan (ESE, 1988c) was developed. These criteria can be grouped into the following three primary categories:

1. Statutory requirements
2. Technical factors
3. Support agency and community acceptance

Statutory requirements are evaluated by meeting the subcriteria of protection of human health and the environment and compliance with ARARs. Technical criteria are assessed by an evaluation of the following subcriteria:

1. Long-term effectiveness and permanence
2. Reduction of toxicity, mobility, and volume
3. Short-term effectiveness
4. Implementability
5. Cost

The support agency and community acceptance criteria are evaluated in the ROD after comments have been received on the RI/EA/FS Report.

The first step in the detailed analysis is to compare each alternative individually to the evaluation criteria. It is extremely important that all assumptions, limitations, and uncertainties be addressed at this stage. These factors should be discussed in evaluating the alternatives against each of the criteria outlined above. Generally, these evaluations are presented in summary tables to facilitate assessment and to provide a standard means of assessing all alternatives.

The final stage in the FS is a comparative analysis conducted to assess the relative performance of each alternative with respect to each specific evaluation criterion. The purpose of this comparative analysis is to identify the advantages and disadvantages of each alternative relative to

each other so that the key tradeoffs the decisionmaker must balance can be identified. Overall protection of human health and the environment and compliance with ARARs will generally serve as threshold determinations in that they must be met by any alternative for it to be eligible for selection. The five technical criteria will require the most discussion because the major tradeoffs among alternatives will most frequently relate to one or more of these five.

4.5 DESCRIPTION OF FS DOCUMENT

The revised FS document will be in the form of a Revised Draft Final EA/FS Report. The FS portion of the EA/FS Report will include all the major components of the FS as outlined above and will provide supporting documentation for the selection of a preferred remedy for the Offpost OU. The FS component will differ from the Draft Final EA/FS primarily as a result of those factors outlined above. It is anticipated that the final format of the report will develop as the result of comments received during routine working sessions with the OAS.

5.0 SCHEDULE AND DESCRIPTION OF DELIVERABLES

Completion of the Offpost RI/EA/FS documents will require that work be performed in the following major categories:

1. Collection of data, including compiling existing data and implementing a field program consisting of well installation and sampling of various media
2. Laboratory analysis of the samples collected and evaluation of the analytical results, and evaluation of the geologic and hydrogeologic data collected
3. Preparation of an addendum to the Final RI Report
4. Preparation of a revised Draft Final EA/FS Report to reflect results of the new RI data and to address comments on the Draft Final EA/FS Report

The work will be completed both sequentially and concurrently, and completion of the entire project, agreed to by the OAS, is estimated to require approximately 13 months from preparation of this Work Plan to the Revised Draft Final EA/FS Report. The Revised Draft Final EA/FS Report is scheduled to be completed on February 1, 1991. Figure 5.0-1 shows a schedule for completion of the entire project.

Certain elements of the field program have been implemented ahead of submittal of this Work Plan to the OAS. Other sampling elements are dependent on acquiring the necessary well permits from state and local agencies and acquiring land access from the property owners in the area. Completion of the well installations in Study Areas Ib and II is estimated to require four to six weeks, depending on the number of drill rigs operating. An additional three weeks will be required for well development and initial ground-water sampling. The sampling of other media in Study Area Ia will generally be concurrent with well installation and sampling. Some of the biota sampling is seasonally controlled and may occur either earlier or later.

Evaluation of the preliminary analytical data and interpretation of the geologic and hydrologic data will begin as soon as data are available and will be ongoing as additional data are collected and transmitted. Preliminary laboratory results from the analytical testing most commonly will be received within 30 to 40 days. Final verification of the data is expected to

ACTIVITY	1989											1990											1991
	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.				
MEETINGS WITH ORGANIZATIONS	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
WORK PLAN PREPARATION																							
FIELD PROGRAM																							
Land Access for Wells	-																						
Well Installation and Sampling	-																						
Other Media Sampling and Analysis	-																						
Produce RI Addenda																							
EA REVISION																							
96th Avenue RA																							
Develop Exposure Methodology																							
Indicator Chemical Selection																							
Exposure Assessment																							
Risk Characterization/Assessment																							
Report Revision/Preparation																							
FS REVISION																							
Evaluate Need for Alternatives																							
Develop ARAs-each Media																							
Develop RAOs																							
Technology Inventory and Screening																							
Generate/Screen Alternatives																							
Formulate Multi-Media Alternatives																							
Evaluate Alternatives/Report Prep.																							
DOCUMENT REVIEW/REVISION/PRODUCTION																							

R - Report
 OR - Organizations
 AR - Army
 - Meetings

OFFPOST EA / FS SCHEDULE

Prepared for:
**Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado**

Figure 5.0-1

SCHEDULE FOR COMPLETION OF THE RI/EA/FS DOCUMENTS

require an additional 25 working days following receipt of data to perform QC reviews as specified in the QAP.

Preparation of the RI addendum will be initiated following completion of the field program and will proceed through receipt and verification of the analytical data. The completion date for the Draft RI Addendum is anticipated as mid-1990, although a report will not be released until the EA/FS report is drafted. As shown in Figure 5.0-1, the components of the EA and FS require that some steps be completed before another can be initiated.

Revision of both the EA and FS portion of the Revised Draft Final EA/FS Report can be initiated in the near future because portions of the revisions are based on re-evaluation of existing data. Modifications may be required as new data are received; however, some of the new data have been collected, and much of the work is not dependent on the new data.

During the course of the investigation, working meetings with the OAS will be held to check progress and to resolve outstanding technical or procedural issues. Tentative dates for these meetings are also shown on the schedule.

6.0 REFERENCES

Consent Decree, 1988, June. United States of America, Plaintiff, v. Shell Oil Company, Inc., Defendant. In the United States District Court for the District of Colorado. Civil Action No. 83-2379.

Ebasco Services, Inc., 1989, Technical Support for Rocky Mountain Arsenal Draft Final Water Remedial Investigation Report, Denver, Colorado, Contract Nos. DAAK11-84-D0016 and DAAA15-88-D0024.

Environmental Science and Engineering, Inc., 1988a, Rocky Mountain Arsenal Offpost Operable Unit Remedial Investigation and Chemical Specific Applicable or Relevant and Appropriate Requirements Final Report (White), Denver, Colorado, Contract No. DAAK11-84-D0016, Task 39.

Environmental Science and Engineering, Inc., 1988b, Rocky Mountain Arsenal Onpost Operable Unit Technology Inventory and Screening Final Report (White), Denver, Colorado, Contract No. DAAK11-84-D0016.

Environmental Science and Engineering, Inc., 1988c, Rocky Mountain Arsenal Offpost Operable Unit Remedial Investigation/Endangerment Assessment, Feasibility Study Technical Plan, Denver, Colorado, Contract No. DAAK11-84-D0016.

Environmental Science and Engineering, Inc., 1989, Biota Remedial Investigation, Final Report - Version 3.2, Denver, Colorado, Contract No. DAAK11-84-D0016.

Harding Lawson Associates, 1989a, Rocky Mountain Arsenal Offpost Operable Unit Endangerment Assessment/Feasibility Study with Applicable or Relevant and Appropriate Requirements Draft Final Report (Brown), Denver, Colorado, Contract No. DAAA15-88-D0021.

Harding Lawson Associates, 1989b, Offpost Interim Response Action and Remedial Investigation/Feasibility Study, Draft Final Field Operations Procedures Plan (Brown), Denver, Colorado, Contract No. DAAA15-88-D0021.

Harding Lawson Associates, 1989c, Offpost Interim Response Action and Remedial Investigation/Feasibility Study, Draft Final Quality Assurance Plan (Brown), Denver, Colorado, Contract No. DAAA15-88-D0021.

Harding Lawson Associates, 1989d, Offpost Interim Response Action and Remedial Investigation/ Feasibility Study, Draft Final Data Management Plan (Brown), Denver, Colorado, Contract No. DAAA15-88-D0021.

Harding Lawson Associates, 1989e, Offpost Interim Response Action and Remedial Investigation/Feasibility Study, Draft Final Health and Safety Plan (Brown), Denver, Colorado, Contract No. DAAA15-88-D0021.

Robert L. Stollar, and Associates, 1988a, Comprehensive Monitoring Program Biota Monitoring Draft Final Technical Plan (Brown), Denver, Colorado, Contract No. DAAA15-87-0095.

Robert L. Stollar and Associates, 1988b, Comprehensive Monitoring Program, Air Quality Monitoring Draft Fund Technical Plan (Brown), Denver, Colorado, Contract No. DAAA15-87-0095.

Robert L. Stollar and Associates, 1989, Comprehensive Monitoring Program, Annual Ground Water Report for 1988, Final Report (White), Denver, Colorado, Contract No. DAAA15-87-0095.

U.S. Environmental Protection Agency, 1985, EPA Guidance Letter Regarding Waste Handling from R.L. Dupuy, EPA, to Colonel W.N. Quintrell, Department of the Army, (July 19).

7.0 ACRONYMS AND ABBREVIATIONS

ac-ft	acre-feet
ac-ft/mo	acre-feet per month
ac-ft/yr	acre-feet per year
AEI	Applied Environmental, Inc.
A1	A sand zone - lower
Am	A sand zone - middle
As	A sand zone - channel
ASTM	American Society for Testing and Materials
Au	A sand zone - upper
BOD	Biological Oxygen Demand
CDH	Colorado Department of Health
CF&I	Colorado Fuel and Iron
cfs	cubic feet per second
cm/sec	centimeters per second
CO	carbon monoxide
COE	U.S. Army Corps of Engineers
COR	Contracting Officer's Representative
COS	combined organosulfur compounds
CPMS	chlorophenylmethyl sulfide
CPMSO	chlorophenylmethyl sulfoxide
CPMSO ₂	chlorophenylmethyl sulfone
CRL	certified reporting limits
CSU	Colorado State University
CSU-GWFlow	Colorado State University Ground-Water Flow Model
CWP	Composite Well Program
DATS	Denver Air Toxics Study

DBCP	dibromochloropropane
11DCE	1,1-dichloroethylene
12DCE	trans-1,2-dichloroethylene
11DCLE	1,1-dichloroethane
DCPD	dicyclopentadiene
DDT	dichlorodiphenyltrichloroethane
DIMP	diisopropylmethyl phosphonate
DMDS	dimethyldisulfide
DMMP	dimethylmethyl phosphonate
EA	Endangerment Assessment
EPA	U.S. Environmental Protection Agency
ESE	Environmental Science and Engineering, Inc.
°F	degrees Fahrenheit
FCP	First Creek Paleochannel
Fm	formation
FRICO	Farmer's Reservoir and Irrigation Company
FS	Feasibility Study
ft	feet
ft ³	cubic feet
ft/day	feet per day
ft/yr	feet per year
FY87	Fiscal Year 1987
gal/ft ²	gallons per square foot
GB	Sarin (nerve agent)
GC/MS	gas chromatography/mass spectrometry
gpd/ft	gallons per day per foot
gpd/ft ²	gallons per day per square foot

gpm	gallons per minute
H	Levinstein mustard
HCCPD	hexachlorocyclopentadiene
HGU	Hydrogeologic unit
HLA	Harding Lawson Associates
ICAP	inductively-coupled argon plasma
ICS	Irondale Containment System
ID	inside diameter
in/mo	inches per month
iph	inches per hour
IRIS	Integrated Risk Information System
K	hydraulic conductivity
K _d	partition coefficient
LA	Lignite A
LB	Lignite B
lbs/ft ³	pounds per cubic foot
LC	Lignite C
LD	Lignite D
MCL	maximum contaminant level
mg/l	milligrams per liter
mi	miles
MIBK	methylisobutyl ketone
MKE	Morrison-Knudsen Engineers, Inc.
mm	millimeter
mph	miles per hour
MRI	Midwest Research Institute
msl	mean sea level

NAAQS	National Ambient Air Quality Standards
NBCS	North Boundary Containment System
NBE	north boundary east
NBTP	North Boundary Treatment Plant
NBW	north boundary west
NO _x	Nitrogen Oxides
NWBCS	Northwest Boundary Containment System
NWBP	Northwest Boundary Paleochannel
O ₃	ozone
OAS	Organizations and State
OD	outside diameter
Iu	number I upper sand
PCE	tetrachloroethylene
PI	plasticity index
PID	photoionization detector
PM-10	particulate matter less than 10 microns in diameter
PMRMA	Program Manager for Rocky Mountain Arsenal
PMSO	Program Manager Staff Office
p,p'-DDE	p,p'-1,1-Dichloro-2,2-bis(4-chlorophenyl)-ethylene
p,p'-DDT	p,p'-Dichlorodiphenyltrichloroethane
PPLV	Preliminary Pollutant Limit Value
ppm	parts per million
psi	pounds per square inch
PVC	polyvinyl chloride
RCI	Resource Consultants, Inc.
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation

RIC	RMA Information Center
RI/FS	Remedial Investigation/Feasibility Study
RLSA	Robert L. Stollar and Associates
RMA	Rocky Mountain Arsenal
RMA-ED	Rocky Mountain Arsenal Environmental Division
SACWSD	South Adams County Water and Sanitation District
SCC	Shell Chemical Company
SCS	Soil Conservation Service
Shell	Shell Chemical Company
SIA	Stapleton International Airport
SO _x	sulfur oxides
SPHEM	Superfund Public Health Evaluation Manual
sq mi	square mile
STP	Sewage Treatment Plant
SVOC	semivolatile organic compounds
SW/GW	Surface Water/Ground Water
SYA	apparent specific yield
T	transmissivity
TCE	trichloroethene
111TCE	1,1,1-trichloroethane
112TCE	1,1,2-trichloroethane
TCLEE	tetrachloroethane
TRCLE	trichloroethane
TSP	total suspended particulates
µg/g	micrograms per gram
µg/l	micrograms per liter
µg/m ³	micrograms per cubic meter

Army	U.S. Department of the Army
USAEHA	U.S. Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USCS	Unified Soil Classification System
UTM	Universal Transverse Mercator
VC	volcaniclastic interval
VCE	clay-rich stratigraphically equivalent zone to VC
VOC	volatile organic compound
WES	U.S. Army Corps of Engineers Waterways Experiment Station
WRI	Water Remedial Investigation
WWII	World War Two

Appendix A

**DETAILED APPROACH FOR THE
96th AVENUE RISK ASSESSMENT**

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INTRODUCTION

This Detailed Approach for the 96th Avenue Risk Assessment presents the scope of work and schedule proposed by Harding Lawson Associates (HLA) and its subcontractor Hunter/ESE for performing a risk assessment of an area north of RMA bounded on the south by 96th Avenue, referred to as the "96th Avenue area." HLA submitted the "Draft Final Report of the Offpost Operable Unit Endangerment Assessment/Feasibility Study with Applicable or Relevant and Appropriate Requirements" (EA/FS, Version 2.1) to the Organizations¹ and State (OAS) in March 1989. Review comments from the OAS suggested that residents in the 96th Avenue area may be exposed to unacceptable levels of contaminants derived from the Rocky Mountain Arsenal (RMA). Other comments noted that the Army did not utilize all data potentially available and that certain of these data were applicable to the 96th Avenue area. The Army, in subsequent discussions with the OAS, elected to perform a focused public health risk assessment to estimate the potential health risks associated with conditions in the vicinity of 96th Avenue. The assessment will be conducted in advance of the revised EA as a result of concerns regarding potential health risks to persons currently living in the area.

The findings of the 96th Avenue risk assessment will ultimately be assimilated into the revised EA because some of the assessment factors developed for the 96th Avenue assessment may be applicable to the EA revision. It should be noted, however, that the characteristics of the two studies are slightly different. Consequently, the assessment techniques utilized in each study will differ. For example, the 96th Avenue risk assessment will assess site-specific and population-specific risks to a subset population of one study area and will utilize data specific to that area and that population. The revised EA will assess potential risks and exposures to a variety of potential populations in five separate study areas, and will utilize factors that are more general in nature.

¹ U.S. Army, U.S. Environmental Protection Agency, and Shell Chemical Company

PURPOSE

The purpose of the risk assessment is to assess the actual potential human health hazards associated with existing environmental conditions in the area of 96th Avenue. Information supplied by the risk assessment, while considering additional policy and economic factors, can be used to evaluate appropriate risk management options.

STUDY AREA

This risk assessment will focus on a discrete human population potentially impacted by past activities at RMA. Additionally, in response to comments from EPA and others, the risk assessment will employ site-specific data to the extent practicable. The study area, which is illustrated in Figure 1.0, has been defined to address these criteria.

The risk assessment will be applicable to all persons having permanent residence within the boundaries of the study area shown in Figure 1.0. Exposure scenarios will be developed to assess the potential health risks to humans within the study area.

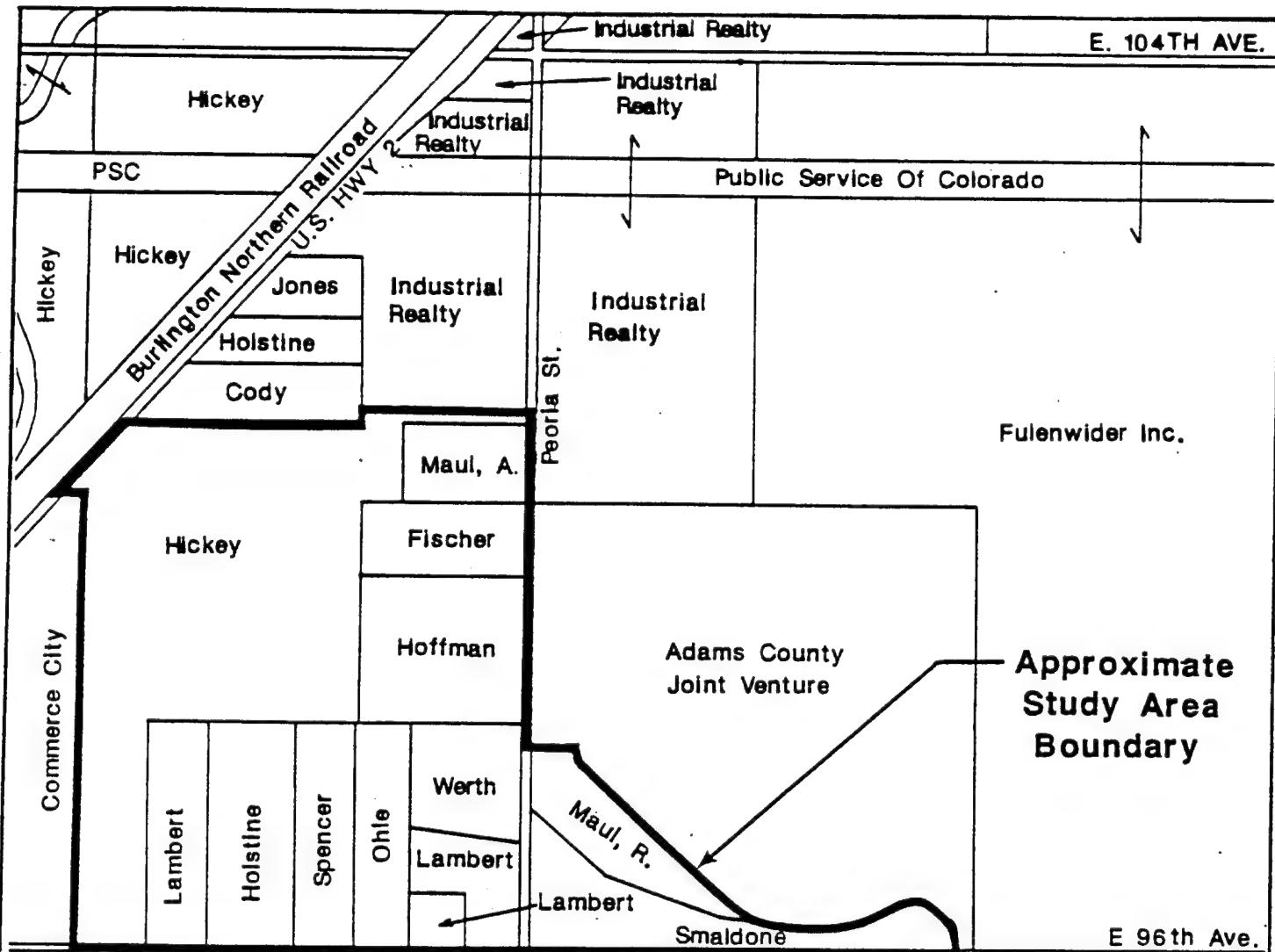
Data that have been subjected to appropriate quality assurance/quality control (QA/QC) review and that have been accepted by the Army will be utilized. The sample collection cut-off date for candidate data is November 1, 1989.

The data base that will form the basis of the risk assessment is specific to the study area. Table 1 identifies the types of data that will be used for the risk assessment.

TECHNICAL APPROACH

The approach intended for application is the traditional environmental pathway model generally applied to hazardous-waste site assessments. The method is described by EPA in the Risk Assessment Guidance for Superfund (RAGS), OSWER Directive 9285.701A (July 1989). HLA will utilize RAGS for general guidance; however, site-specific exposure and dose factors will be used to the maximum extent possible.

The following five subtasks comprise the technical approach.



Explanation

A horizontal scale bar with tick marks at 0, 1000, and 2000. A vertical line extends from the 1000 mark to the text "Scale In Feet" below the bar.

Connects Individual Pieces Of
The Same Parcel.

**Study Population Includes All Permanent
Residents Living In The Study Area.**

Prepared for:
Program Manager for
Rocky Mountain Arsenal
Commerce City, Colorado

**FIGURE 1.0
STUDY AREA,
96TH AVENUE RISK ASSESSMENT**

Table 1: 96th Avenue Risk Assessment Data Base

<u>Media</u>	<u>Location</u>	<u>Date Collected</u>
Surface water/sediment	First Creek - within the study area	November 1988 ¹
Fish	First Creek Impoundment	November 1988
Tap water ²	Study area residences	January 1989, April 1989, and September 1989 ¹
Surface soil	Study area residences	February 1989
Chicken eggs	Study area residences	April 1989
Sump discharge soil	Study area (Collins) residences	April 1989
Bovine tissues	Study area residences	August 1989 and October 1989
Bovine milk	Study area residences and a local dairy	August 1989
Chicken tissues	Study area residences	September 1989
Air	Offsite and onsite sampling stations relevant to the study area	1988-1989

¹ Data collected before these dates are available and will be used, if applicable.

² It is not expected that ingestion of tap water is a viable exposure pathway because alluvial system ground water is not used as a drinking water resource. However, the tap-water analyses will be reviewed to screen for RMA-associated contaminants.

Note: The Colorado Department of Health (CDH) has collected data from the study area. HLA will attempt to obtain the CDH data because of its potential applicability to the study; however, because the data have not undergone Army analytical review, use of the data will be limited to qualitative applications.

Subtask 1: Project Planning

This subtask addresses all project planning activities, including identification of project scope, specification of data requirements, and preparation of this document.

Subtask 2: Method Development

This subtask will develop exposure estimation methods to determine receptor intake of contaminants. The subtask comprises the following activities:

1. Assessing existing information in view of the exposure factor data that will be developed by the survey (discussed in Subtask 3)
2. Identifying equations, calculations, and supporting information required for estimating exposures
3. Briefing the OAS and incorporating appropriate comments regarding methodology

The briefing will be accomplished by distributing a memorandum that defines the calculations to be performed and the source of input parameters, followed by a meeting with the OAS to discuss the study methodology. Follow-up and revision, as appropriate, will complete the subtask.

Subtask 3: Design and Conduct a Survey of Exposure Variables Among Individuals Living Within the Study Area

The purpose of the survey is to determine the daily activities as well as less frequent activities that may bring a potential receptor into contact with study area contaminants that may be associated with RMA. The survey will be conducted by HLA either by interview or other means, as necessary. Activities performed under this subtask include:

1. Developing the questionnaire, followed by review and discussion of its implementation with PMRMA. HLA will modify the questionnaire, as appropriate, following comment by PMRMA.
2. Summarizing and evaluating information acquired.

Information developed from the interviews as well as the observations of individuals conducting the survey will form the basis for estimating contaminant intakes through contact

with potentially affected media in the study area. This subtask will include developing media contact and intake profiles using information obtained through the survey. The evaluation of these data will include comparison with literature reference values for intake and other contact points.

Subtask 4: Conduct the Exposure Assessment

Incorporation of the first three tasks into a comprehensive exposure assessment is the fourth subtask. This subtask is central to the study because it produces exposure dose estimates, which define the quantity of contaminant potentially entering the body of a receptor. The subtask includes the following activities:

1. Defining input parameters from survey data and public domain reference materials for exposure estimation calculations
2. Performing calculations and subjecting computations to sensitivity and uncertainty analysis

In cases where appropriate scientific data exist, development of target organ doses will be investigated. Target organ doses developed from exposure doses are applicable to the toxicological evaluation aspects of the risk assessment.

Upon completion of this subtask, daily site-specific contaminant intake values and a characterization of their variances will be available for use in the risk assessment.

Subtask 5: Risk Characterization

The risk characterization will estimate the potential for unacceptable risks to the human population in the study area. Potential risks will be projected, and an estimate of the associated uncertainties for the noncarcinogenic and carcinogenic compounds will be developed. When adequate toxicology profile information is available, risks will be determined on the basis of subchronic and acute exposures as well as chronic exposures. Where appropriate, the risks associated with exposure will be assessed on the basis of (1) type of toxicological effect and (2) organ-specific location of effect. The risk assessment will be conducted to realistically

characterize, to the extent possible, the actual public health hazards associated with the study area. This assessment will require an unbiased evaluation of the factors involved in exposure assessment and the risk characterization.

Subtask 6: Memorandum Preparation and Meetings

This subtask includes preparation of a memorandum and preparation for, attendance at, and follow-up to meetings. The memorandum that HLA and Hunter/ESE anticipate for presenting of the findings is described in the "Reporting" section of this Detailed Approach for the 96th Avenue Risk Assessment. Details on the number of meetings anticipated are included in Attachment A.

QUALITY ASSURANCE/QUALITY CONTROL

Table I indicates that site-specific chemical/analytical data will be utilized in estimating exposure levels. Most data identified in Table I have been collected and analyzed in accordance with procedures outlined in the "Draft Final Quality Assurance Plan" (QAP) (HLA, August 1989). Under the guidance of PMRMA, some data presented in Table I (e.g., DIMP in bovine milk) have been collected and analyzed outside the purview of the QAP because validated analytical methods were not available. These data will be utilized, if appropriate, with guidance from PMRMA.

The survey questionnaire will be developed with recognition of the need to obtain accurate, reliable information from respondents. To accommodate this requirement, the questionnaire will be worded in a straightforward and concise format.

REPORTING

HLA will prepare a brief memorandum to summarize the findings of the risk assessment. The memorandum will focus primarily on presenting information that is vital to assessing the magnitude of potential human health hazards and to evaluating risk management options. The memorandum will be written with the assumption that readers are familiar with relevant issues at

RMA, the residents in the 96th Avenue study area, and the risk assessment process. The findings will be presented in a summary format that utilizes tables, figures, and succinct, interpretive text. Certain information presented in the findings memorandum will most likely be applicable to the EA and will be incorporated into the revised EA document. For this reason, the findings memorandum will most likely be included as a stand-alone appendix to the revised EA.

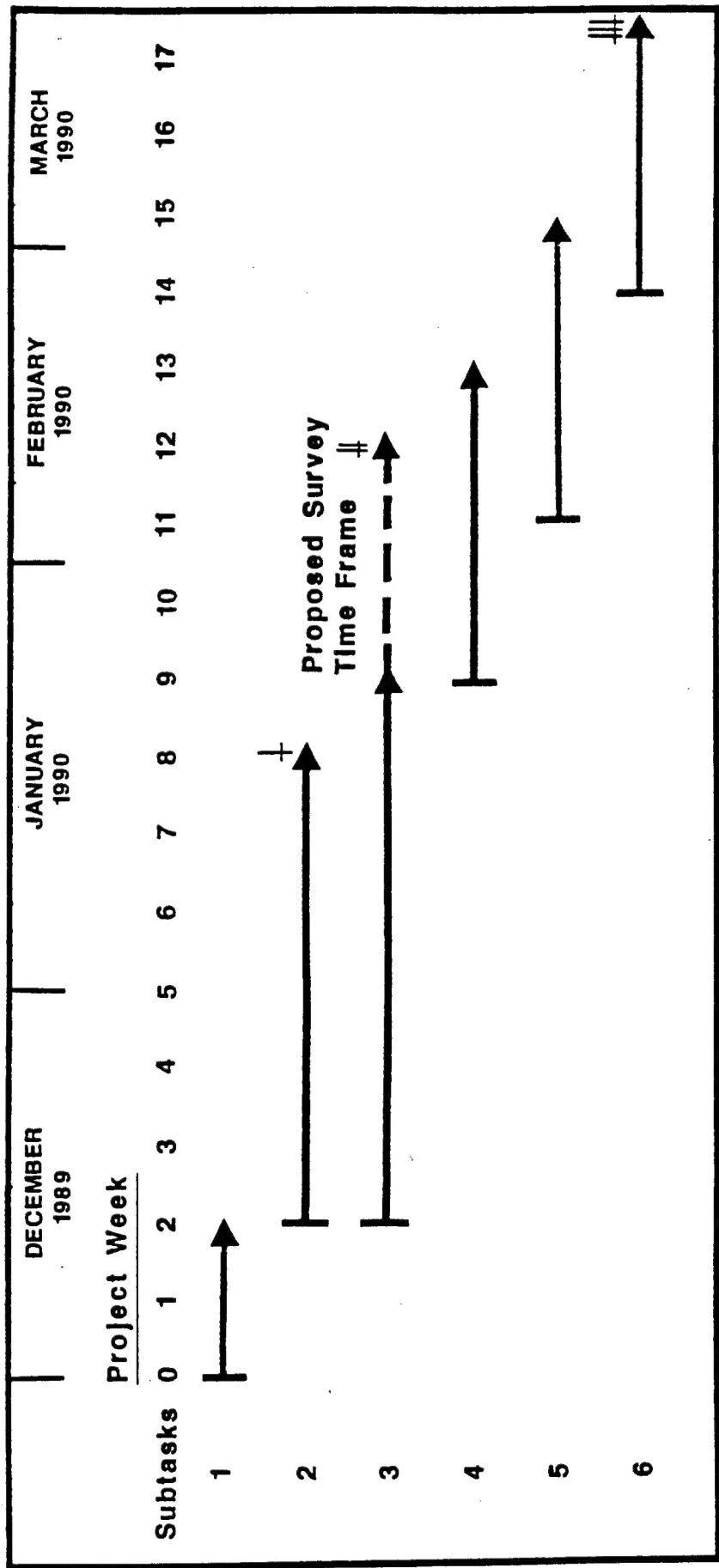
Details on the development of the methods employed to derive the findings will not be presented in the memorandum. Much of the supporting exposure assessment and toxicity information customarily provided in public health risk assessments will be incorporated by reference. We anticipate that the entire memorandum will not exceed 25 pages. We assume that the memorandum will be prepared in draft and draft final versions.

PROJECT TEAM

HLA's project team will work under the general direction of PMRMA. HLA will be the overall technical lead and will receive technical support from Hunter/ESE. HLA's project manager will have day-to-day responsibility for (1) performance of the scope of work, (2) the schedule, and (3) budget control, and (4) HLA's portion of the product. A large portion of the technical work product will be provided by Hunter/ESE's project manager, who will be responsible for this contribution.

SCHEDULE

The proposed project spans a period of 17 weeks from authorization to proceed until delivery of the draft final memorandum. Figure 2.0 shows a subtask milestone schedule that illustrates approximate task relationships. It should be noted that performance of the survey (Subtask 3) is a mid-project rate limiting step because Subtasks 4 and 5 are dependent on the survey information. Based on PMRMA's verbal authorization to proceed received on or about December 1, 1989, a meeting to present the findings to the OAS could be scheduled on or about March 22, 1989.



- + Briefing to Review Method Development
- || HLA Conducts the Survey
- || Meeting for Presentation of Findings

Prepared for:
 Program Manager for
 Rocky Mountain Arsenal
 Commerce City, Colorado

Figure 2.0

PROPOSED SCHEDULE 96TH AVENUE RISK ASSESSMENT